Sandia National Laboratories/New Mexico

PROPOSAL FOR RISK-BASED NO FURTHER ACTION ENVIRONMENTAL RESTORATION SITE 109 BUILDING 9950 FIRING SITE OPERABLE UNIT 1335

August 1997

Environmental Restoration Project

United States Department of Energy
Albuquerque Operations Office

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BUILDING 9950 FIRING SITE
OPERABLE UNIT 1335
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Prepared for
the U.S. Department of Energy

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ACRONYMS

bgs	below ground surface
CAB	cellulose acetate butyrate
CEARP	Comprehensive Environmental Assessment and Response Program
COC	constituent of concern
DOE	Department of Energy
DOU	Document of Understanding
DU	depleted uranium
DV1	Data Validation Level 1
DV2	Data Validation Level 2
EOD	explosive ordnance disposal
EPA	Environmental Protection Agency
ER	Environmental Restoration
ES&H	Environmental Safety and Health
GEL	General Engineering Laboratories
HE	high explosive
HMX	cyclotetramethylene tetranitramine
KAFB	Kirtland Air Force Base
ms/msd	matrix spike/matrix spike duplicate
NFA	No Further Action
NMED	New Mexico Environment Department
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RDX	hexahydro-1,3,5-trinitro-1,3,5-trazine
SMO	Sample Management Office
SNL/NM	Sandia National Laboratories/New Mexico
SWMU	Solid Waste Management Unit
TAL	target analyte list
TNT	trinitrotoluene
UXO	unexploded ordnance
VOC	volatile organic compound

1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a No Further Action (NFA) decision for Environmental Restoration (ER) Site 109, Building 9950 Firing Site, based on confirmatory sampling with risk-based analysis (NFA Criterion 5; NMED 1996).

1.1 Description of ER Site 109

Site 109 is located in the North Thunder Range, 0.4 mile east of Technical Area III and approximately 6,000 feet west of Lovelace Road (Figure 1-1). The site is approximately 0.27 acre.

The terrain is generally flat with a gentle slope to the west. Vegetation consists predominantly of grasses including grama, muhly, dropseed, and galleta. Shrubs commonly associated with the grasslands include sand sage, winter fat, saltbrush, and rabbitbush. Cacti are common, and include cholla, pincushion, strawberry, and prickly pear.

The geology (in general) is characterized by a veneer of aeolian sediments underlain by alluvial fan deposits. Based on drilling records of similar deposits at Kirtland Air Force Base (KAFB), the alluvial materials are highly heterogeneous, composed primarily of medium to fine silty sands with frequent coarse sand, gravel, and cobble lenses. Depth to groundwater is approximately 480 feet below ground surface (bgs) based on monitoring well, CWL MW-5, located at the Chemical Waste Landfill, approximately 1.2 miles southwest of the site and monitoring well, MWL MW-4, located at the Mixed Waste Landfill, approximately 1 mile west of the site.

A detailed review of the local setting for Site 109 is documented in the "Resource Conservation and Recovery Act (*RCRA)* Facility Investigation (RFI) Work Plan for Operable Unit 1335, Southwest Test Area" (SNL/NM 1996).

1.2 No Further Action Basis

Review and analysis of all relevant data for ER Site 109 indicate that concentrations of constituents of concern (COC) at this site are less than (1) SNL/NM or other applicable background limits, or (2) proposed Subpart S or other action levels, or (3) applicable risk assessment action levels. Thus, ER Site 109 is being proposed for an NFA decision based on confirmatory sampling data demonstrating that COCs that may have been released from this solid waste management unit (SWMU) into the environment pose an acceptable level of risk under current and projected future land use, per NFA Criterion 5 of the ER Document of Understanding (DOU) (NMED 1996).

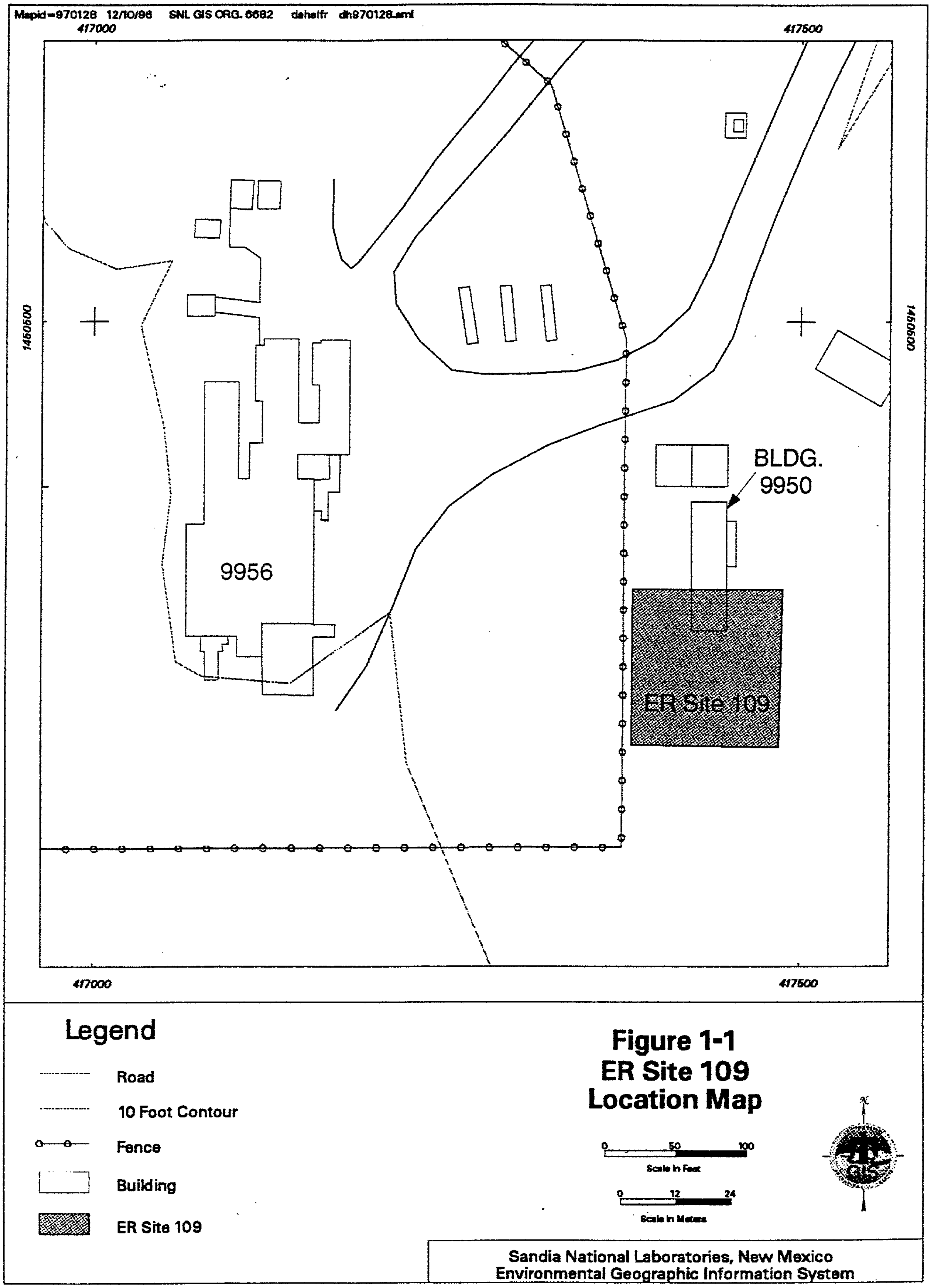


Figure 1-1
ER Site 109
Location Map

2.0 HISTORY OF ER SITE 109

This section provides a summary of the historical information that has been obtained for the site.

2.1 Historical Operations

ER Site 109 was operational from 1963 to approximately 1969. The site had two general test locations used to study shock wave phenomena from explosive tests. One area (test pits) was located south/southeast of Building 9950, and the other area was located on a test pad on top of Building 9950. Building 9950 is an earthen-covered bunker, bermed on three sides. The two test locations are discussed below.

2.1.1 Test Pits South/Southeast of Building 9950

Tests were conducted by burying a unit consisting of an explosive charge of beryllium (Be)-containing metal sheets, called coupons, and then detonating the unit in a test pit. The explosive tests were performed in excavated pits south/southeast (SNL/NM 1994b; Refs. 18, 63, 640, 856, 854) of Building 9950. The tests were conducted between 50 to 150 feet south/southeast of Building 9950 due to instrumentation cabling constraints (SNL/NM 1994b; Refs. 856, 854). A typical experiment was set up in the bottom of a pit, covered with a plywood box, and then covered with sand bags (SNL/NM 1994b; Refs. 854, 71). The test pits were excavated 8 feet deep, 6 feet long, and about 3 to 4 feet wide in native soil (SNL/NM 1994b; Ref. 854). Once a test pit was used, another one was excavated in the same area (SNL/NM 1994b; Ref. 854).

The coupons used in the tests were called beryllides, a material containing some (probably less than 20 percent by volume) beryllium (SNL/NM 1994b; Refs. 640, 854) and were 1.5 inches in diameter and 0.25 to 0.125 inch thick (SNL/NM 1994b; Ref. 854). The shaped charges used in the tests were pads approximately 6 inches in diameter, typically containing 15 to 20 pounds of explosives with a maximum of 30 pounds of explosives (SNL/NM 1994b; Refs. 854, 856). The explosives used included baratol, trinitrotoluene (TNT), Composition B, Boracitol, plastic-bonded hexahydro-1,3,5-trinitro-1,3,5-trazine (RDX), nitroguanadine, and detasheet/detacord (SNL/NM 1994b; Refs. 854, 856). All explosives used in the tests were completely consumed upon detonation (SNL/NM 1994b, Refs. 63, 854). After the test, the residues in the test pit were analyzed, and the pit was backfilled (SNL/NM 1994b; Ref. 63). No post-test cleanup was performed (SNL/NM 1994b; Ref. 71).

Fifteen lithium hydride tests may also have also been conducted in similar pits (SNL/NM 1994b; Ref. 640, 854). Supervisors at the site were not aware of any tests involving depleted uranium (DU) or any other radioactive materials (SNL/NM 1994b; Ref. 854, 856).

Additionally, there was a steel-lined pit just south of Building 9950 (SNL/NM 1994b; Refs. 640, 858). The SNL/NM Safety Department had the pit filled in to eliminate a fall hazard. No surficial evidence of this pit remains at the site. Personnel who worked at the site said they had no idea what the steel lined pit could have been used for and that it was not used by their organization for explosive tests.

2.1.2 Tests Conducted on Top of Building 9950

Hundreds of tests were conducted on a pad on top of Building 9950. Building 9950 is an earthen-covered bunker, bermed on three sides, that served as the control bunker for tests performed at the site. Approximately four tests were conducted per day, two to three times per week (SNL/NM 1994b, 854). The "experimental" coupons used in the tests were made of aluminum or copper, and were typically 1.5 inches in diameter and 0.25 to 0.125 inch thick (SNL/NM 1994b, Ref. 854). Other materials used in tests included lead, carbon, carbon/glass, and stainless steel (SNL/NM 1994b, Ref. 71). Shaped charges consisting of an uncased pad of explosives, approximately 8 inches in diameter, were used in the tests. Approximately 30 pounds of explosives were typically used (SNL/NM 1994b, Ref. 854). Another reference stated that the tests were fairly small, typically involving only a couple pounds of explosives (SNL/NM 1994b, Ref. 856). The explosives used in the tests typically included baratol, RDX, and cyclotetramethylene tetranitramine (SNL/NM 1994b, Ref. 71). All explosives used in the tests were consumed upon detonation (SNL/NM 1994b, Ref. 63, 854). Test debris was driven into the earthen roof and not off of the roof of the bunker (SNL/NM 1994b, Ref. 856). One reference stated that there may be some residual barium in the roof soils from the baratol (SNL/NM 1994b, Ref. 71).

Two tests involving DU were conducted on the pad on top of Building 9950, but the residue was cleaned up (SNL/NM 1994b, Ref. 63). Tests using nitroguanadine were also conducted on the ground surface at the base of the earthen berm on the south side of Building 9950. These tests involved approximately 30 pounds of explosives per shot (SNL/NM 1994b, Ref. 854).

One interviewee indicated that flyer plate experiments were conducted on the pad on top of Building 9950 (SNL/NM 1994b; Ref. 854). Another interviewee indicated that the flyer plate experiments were performed on the mesa southeast of the building (SNL/NM 1994b; Ref. 856). The tests used an 8 inch diameter explosive charge to accelerate a flyer plate through the air to a target (SNL/NM 1994b; Ref. 854). Explosives used were baratol and TNT (SNL/NM 1994b; Ref. 854). Very few (less than six) experiments were conducted due to spalling of the flyer plates (SNL/NM 1994b; Ref. 854). The flyer plates were made of standard materials such as aluminum, copper, and 4340 steel (SNL/NM 1994b; Ref. 854).

2.2 Previous Audits, Inspections, and Findings

The site was first listed as a potential SWMU by the "Comprehensive Environmental Assessment and Response Program (CEARP), Phase I: Installation Assessment, Sandia National Laboratories, Albuquerque, New Mexico" [DRAFT] (DOE 1987). The listing was based on HE tests that were conducted on a test pad on top of Building 9950, and in test pits south/southeast of Building 9950. The tests were conducted with HE and beryllium, lead, carbon, carbon glass, and DU components.

The original ER site name was the Building 9956 Firing Site (DOE 1987). During the development of the Operable Unit 1335 RFI Work Plan (SNL/NM 1996), it was discovered that

Firing Site activities were associated with Building 9950. During the CEARP interviews, it was stated that explosive tests were conducted on the roof of Building 9956 (SNL/NM 1994b; Ref. 71). Building 9956 was built in approximately 1969 according to "as built" drawings generated by SNL/NM Facilities Engineering. Building 9956 therefore did not exist at the time of the tests (1963 to 1969). Construction drawings for Building 9956 and site visits clearly show that no explosive testing could be conducted on the roof as there is no pad, and an explosive detonation on unreinforced sheet metal would destroy the building and the roof. Therefore, references to explosive tests on the roof of Building 9956 are considered invalid and will not be pursued. The test pad was clearly on top of Building 9950. The site was therefore renamed the "Building 9950 Firing Site."

3.0 EVALUATION OF RELEVANT EVIDENCE

The following sections discuss the recent field investigations, the analytical results associated with the field activities, and the human health and ecological risk assessments.

3.1 Unit Characteristics and Operating Practices

ER Site 109 was used to study shock wave phenomena from explosive tests. Only partial containment safeguards were built into the tests conducted in the pits. The pits were approximately 8 feet deep, 6 feet long, and 3 to 4 feet wide. The experiments were conducted in the bottom of the pits, covered with a plywood box, and then covered with sand bags. Each test was contained within the pit. There was no containment associated with the tests conducted on top of Building 9950. The tests were performed on a soil test pad in open air.

Hazardous wastes were not managed or contained at ER Site 109.

3.2 Results of SNL/NM ER Project Sampling/Surveys

The following summary of the ER Site 109 field investigations and the evaluation of the data collected and analyzed from those investigations provide the needed information to recommend ER Site 109 for an NFA under DOU Criterion 5 (NMED 1996).

3.2.1 Summary of Prior Investigations

The following sources of information, presented in chronological order, were used to evaluate ER Site 109:

- Interviews with former site employees (SNL/NM 1994b).
- Archaeological/cultural resources survey (DOE 1996a) and a sensitive or special status species or environments survey (DOE 1996a).
- Unexploded Ordnance/High Explosives (UXO/HE) Visual Survey (SNL/NM 1994c).
- Surface Gamma Radiation Surveys (RUST Geotech Inc. 1994).
- Draft RFI Work Plan for Operable Unit 1335, Southwest Test Area (SNL/NM 1996).
- Surface and subsurface soil sampling (June 1996).
- Photographs and field notes collected at the site by SNL/NM ER staff.

3.2.2 UXO/HE Survey

From September 1993 to July 1994, the explosive ordnance disposal (EOD) unit visually surveyed 89 ER sites (including Site 109) for UXO/HE and ordnance debris. No UXO/HE or ordnance debris was found during the survey at Site 109 (SNL/NM 1994c).

3.2.3 Radiological Surveys

RUST Geotech Inc. conducted a surface radiological assessment at Site 109 in March of 1994. The assessment was conducted to identify and delineate areas exhibiting anomalous surface gamma radiation. Surface radiation surveys were performed with Geotech Model EL-0047A crutch scintillometers, which measure gross gamma activity in counts per second. Physical land surveys were performed in conjunction with the radiological survey to spatially locate site boundaries, cultural features, and gamma anomalies.

The Site 109 gamma scan was performed on 6-foot centers over a surface area of 0.5 acres. The interior of Building 9950 was excluded from the survey. No areas of gamma activity 30 percent or greater than the natural background level were found within the site (survey) boundaries (RUST Geotech Inc. 1994).

3.2.4 Site 109 Field Investigation

The following subsections provide a summary of the Site 109 field investigation activities, and the evaluation of the data collected and analyzed during the investigation. Site 109 was discussed in Section 4.1.3.1 of the RFI Work Plan (SNL/NM 1996) as a SWMU proposed for NFA. Site 109 was not included in the RFI Sampling and Analysis Plan. A separate confirmatory sampling plan was prepared for the site.

Residual HE may be present in soils surrounding the two Site 109 test areas. Explosive testing may have released baratol, TNT, Composition B, Boracitol, plastic-bonded RDX, nitroguanadine, and detasheet/detacord to the environment in these two test areas. In addition to HE, other test materials may have been released to the environment from the explosive testing. Those materials include aluminum, beryllium, copper, steel, lead, lithium, and barium (from the baratol). DU was dispersed in only two tests on top of Building 9950. The DU debris was reportedly cleaned up after the two tests.

The objective of the field investigation was to determine the vertical and horizontal extent of possible soil contamination at the site. To complete this task, the field activities were divided into two areas based on location: the top of Building 9950 and the test pit(s) located south/southeast of Building 9950. The potential COCs in these two areas are HE, DU, lead, and beryllium as identified in the RFI Work Plan (SNL/NM 1996). In addition, RCRA metals are included in the COC list.

The ER Site 109 field investigation was conducted from June 3, 1996, to June 12, 1996. The field activities included drilling soil borings, collecting surface and subsurface soil samples for chemical and radionuclide analyses, managing the waste generated during drilling, and surveying the sampling locations (Mignardot 1996a).

3.2.4.1 Supplemental UXO/HE Survey

Prior to the drilling and sampling activities at Site 109, a supplemental UXO/HE visual surface survey was conducted by the KAFB EOD unit. No UXO/HE fragments were found at the site (Young 1997).

3.2.4.2 Drilling Program

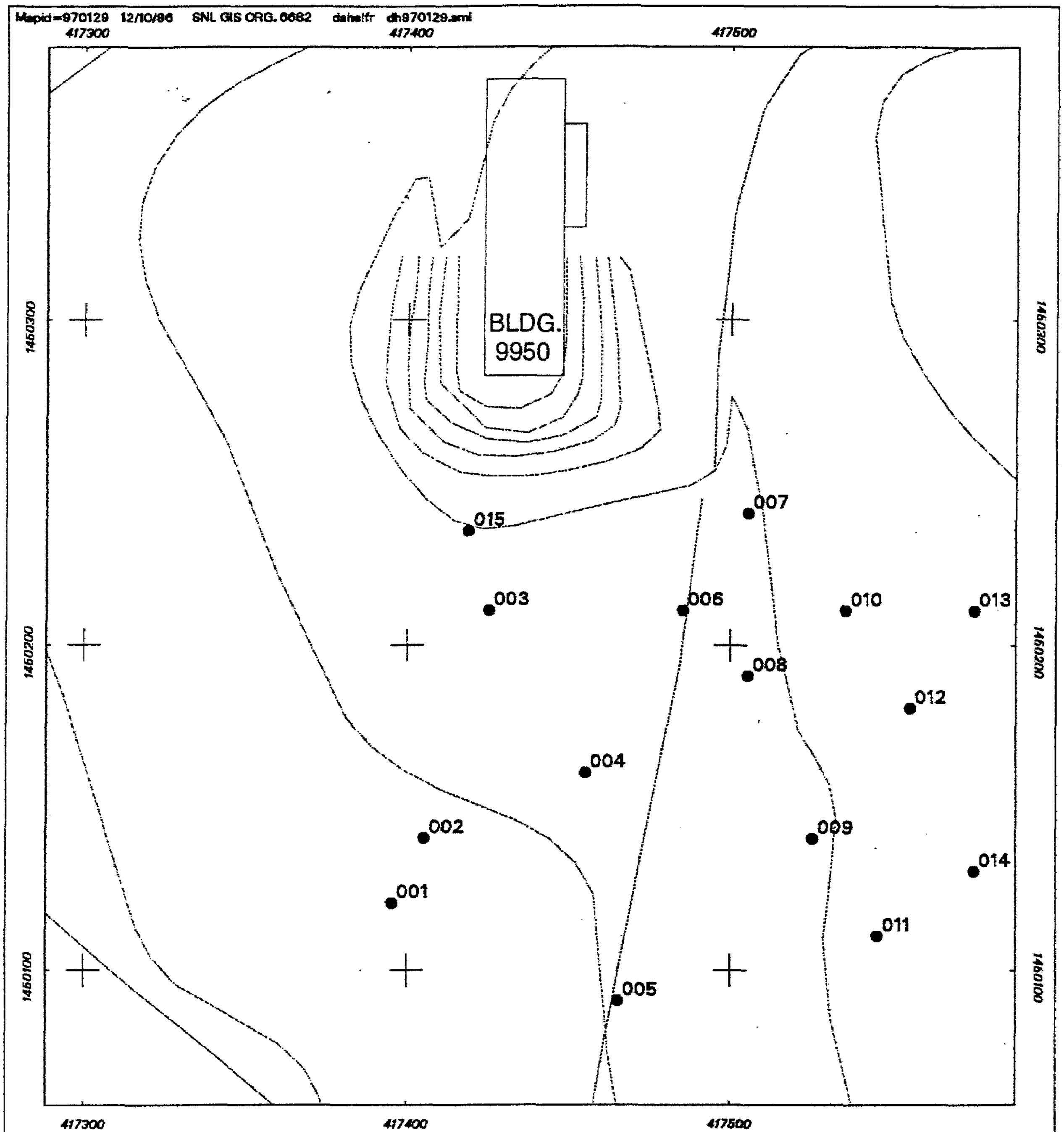
The drilling program was conducted using a truck-mounted Geoprobe® drill rig. A total of 14 soil boreholes (sample locations 109-GR-001 to 109-GR-014) were placed in the area of the test pits south/southeast of Building 9950 (Figure 3-1). During the drilling, a steel cylinder was uncovered. A backhoe was used to excavate and determine the dimensions of the cylinder. The cylinder measured 7 feet wide and 6 feet deep and contained native fill material and clean sand. The cylinder was reburied in its original location. One sample, 109-GR-015, was collected adjacent to the cylinder.

3.2.4.3 Subsurface and Surface Soil Sample Collection

Subsurface soil samples were collected at 8 to 9 feet bgs and 12 to 13 feet bgs from each borehole with a 2.5-inch outside diameter by 4-foot long core sampler that was lined with a cellulose acetate butyrate (CAB) sleeve. Upon removal of the CAB liner from the sampler, the liner was cut into three sections. One section was sealed with tape and prepared for shipment to the off-site laboratory for HE analysis. One section was prepared for transport to the on-site laboratory for target analyte list (TAL) metals analysis and the other section was prepared for shipment to the off-site laboratory for TAL metals analysis. The remaining sample was removed from the liner and placed in Marinelli jars for gamma spectroscopy analyses by the on-site laboratory. At sample location 109-GR-015 (cylinder), samples were collected from the backhoe bucket, so field personnel did not have to enter the excavation. The first soil sample was collected at 4 to 5 feet bgs within the cylinder and the second sample at 7 to 8 feet bgs outside/beneath the cylinder. The sample was composited, placed in appropriate containers, and prepared for shipment to the same laboratories as the other soil samples. The same analyses were specified for the cylinder samples that were specified for the subsurface soil samples discussed above.

Surface soil samples were collected at two general locations, five samples on top of the earthen-covered Building 9950, and five samples along the bottom of the earthen berm on the south side of Building 9950 (Figure 3-2). Each sample was composited, placed in appropriate containers, and prepared for shipment to the same laboratories as specified for the subsurface soil samples. Analyses were performed for HE, TAL metals, and gamma spectroscopy.

The samples collected and the chemical and radiochemical analyses performed on these samples are provided in Table 3-1. Thirty subsurface and ten surface soil samples were



Legend

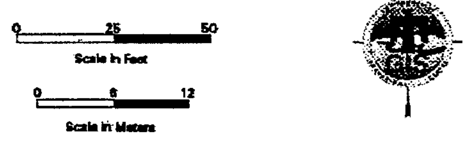
001 Sampling Location (109-GR-)

Road

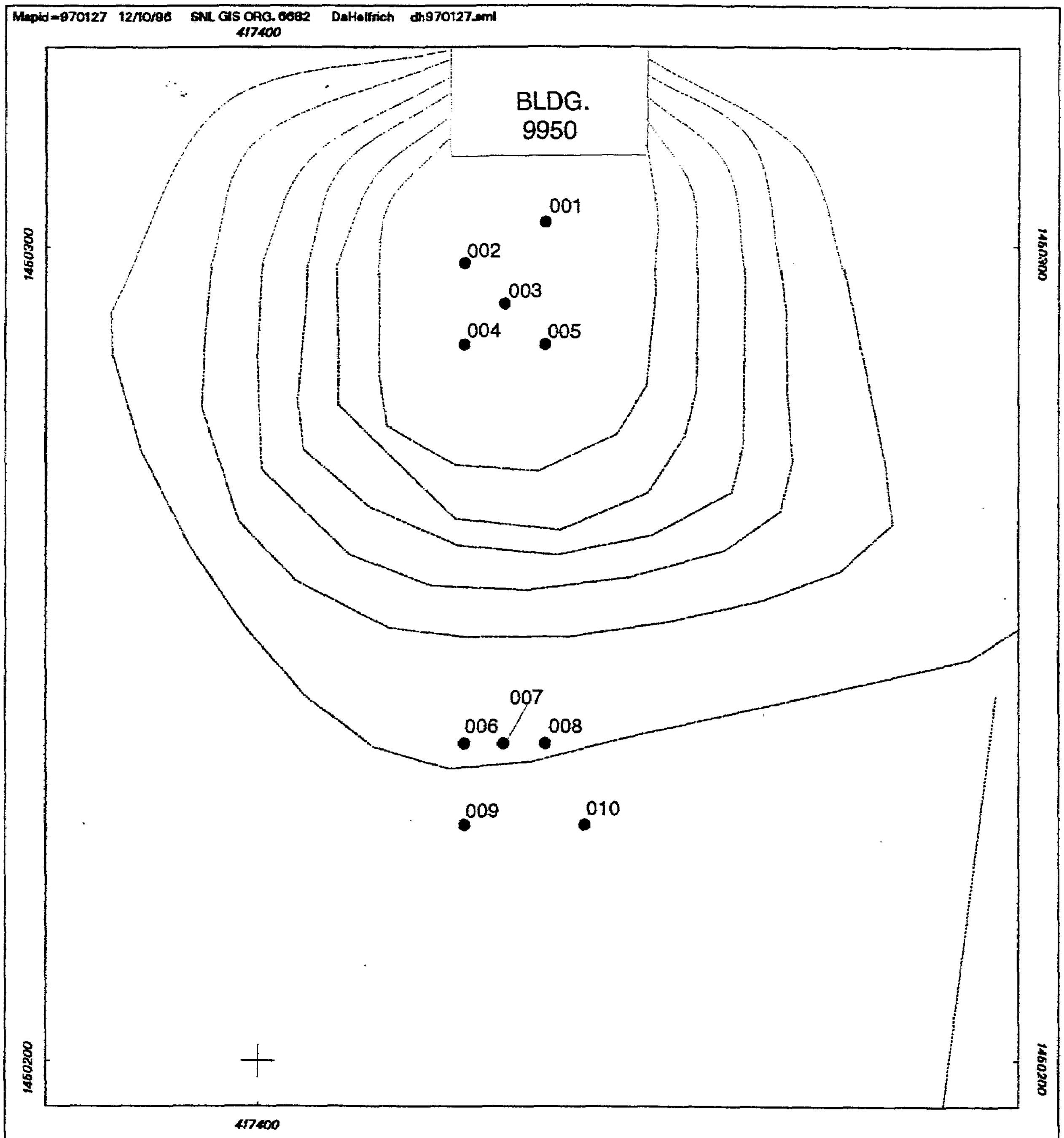
2 Foot Contour

Building

Figure 3-1
Subsurface Soil Sampling Locations at ER Site 109



Sandia National Laboratories, New Mexico
Environmental Geographic Information System



Legend

001 Sampling Location (109-GR-)

Elevation Contour (2 Foot)

Building

Figure 3-2
Surface Soil Sampling Locations at ER Site 109

0 10 20
Scale in Feet

0 2.4 4.8
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Restoration Geographic Information System

TABLE 3-1
ER Site 109: Listing of Samples Collected and Analysis Performed

SAMPLE NUMBER	DATE/TIME SAMPLED	SAMPLE LOCATION	REMARKS	FIELD SCREENING	ON-SITE LAB		OFF-SITE LAB	
				Radiation	Gamma spec.	TAL Metals	High Explosives	TAL Metal
Surface Soil:								
029722-01	6/12/96-0950	109-GR-001-0-6-SS		X	X			
029722-03	6/12/96-0950	109-GR-001-0-6-SS				X		
029722-04	6/12/96-0950	109-GR-001-0-6-SS					X	
029723-02	6/12/96-0950	109-GR-001-0-6-SSD						X
029723-04	6/12/96-0950	109-GR-001-0-6-SSD	Duplicate Sample				X	
029724-01	6/12/96-1015	109-GR-002-0-6-SS		X	X			
029724-02	6/12/96-1015	109-GR-002-0-6-SS						X
029724-03	6/12/96-1015	109-GR-002-0-6-SS				X		
029724-04	6/12/96-1015	109-GR-002-0-6-SS					X	
029725-01	6/12/96-1025	109-GR-003-0-6-SS		X	X			
029725-03	6/12/96-1025	109-GR-003-0-6-SS				X		
029725-04	6/12/96-1025	109-GR-003-0-6-SS					X	
029726-01	6/12/96-1035	109-GR-004-0-6-SS		X	X			
029726-03	6/12/96-1035	109-GR-004-0-6-SS				X		
029726-04	6/12/96-1035	109-GR-004-0-6-SS					X	
029727-01	6/12/96-1045	109-GR-005-0-6-SS		X	X			
029727-03	6/12/96-1045	109-GR-005-0-6-SS				X		
029727-04	6/12/96-1045	109-GR-005-0-6-SS					X	
029728-01	6/12/96-1100	109-GR-006-0-6-SS		X	X			
029728-02	6/12/96-1100	109-GR-006-0-6-SS						X
029728-03	6/12/96-1100	109-GR-006-0-6-SS				X		
029728-04	6/12/96-1100	109-GR-006-0-6-SS					X	
029729-01	6/12/96-1110	109-GR-007-0-6-SS		X	X			
029729-03	6/12/96-1110	109-GR-007-0-6-SS				X		
029729-04	6/12/96-1110	109-GR-007-0-6-SS					X	
029730-01	6/12/96-1120	109-GR-008-0-6-SS		X	X			
029730-03	6/12/96-1120	109-GR-008-0-6-SS				X		
029730-04	6/12/96-1120	109-GR-008-0-6-SS					X	

TABLE 3-1 (Continued)
ER Site 109: Listing of Samples Collected and Analysis Performed

SAMPLE NUMBER	DATE/TIME SAMPLED	SAMPLE LOCATION	REMARKS	FIELD SCREENING	ON-SITE LAB		OFF-SITE LAB	
				Radiation	Gamma spec.	TAL Metals	High Explosives	TAL Metal
029731-01	6/12/96-1130	109-GR-009-0-6-SS		X	X			
029731-03	6/12/96-1130	109-GR-009-0-6-SS				X		
029731-04	6/12/96-1130	109-GR-009-0-6-SS					X	
029732-01	6/12/96-1140	109-GR-010-0-6-SS		X	X			
029732-03	6/12/96-1140	109-GR-010-0-6-SS				X		
029732-04	6/12/96-1140	109-GR-010-0-6-SS					X	
Field Blank:								
029733-01	6/12/96-1200	109-GR-010-FB	Deionized Water		X			
029733-02	6/12/96-1200	109-GR-010-FB	Deionized Water					X
029733-04	6/12/96-1200	109-GR-010-FB	Deionized Water				X	
Equipment Blank:								
034001-01	6/12/96-1210	109-GR-010-EB	Deionized Water		X			
034001-02	6/12/96-1210	109-GR-010-EB	Deionized Water					X
034001-04	6/12/96-1210	109-GR-010-EB	Deionized Water				X	
Subsurface Soil:								
029933-01	6/03/96-1430	109-GR-001-8-9-SS		X	X			
029933-03	6/03/96-1430	109-GR-001-8-9-SS				X		
029933-04	6/03/96-1430	109-GR-001-8-9-SS					X	
029934-02	6/03/96-1430	109-GR-001-8-9-SSD						X
029934-04	6/03/96-1430	109-GR-001-8-9-SSD	Duplicate Sample				X	
029935-01	6/03/96-1440	109-GR-001-12-13-SS		X	X			
029937-02	6/03/96-1440	109-GR-001-12-13-SS						X
029935-03	6/03/96-1440	109-GR-001-12-13-SS				X		
029935-04	6/03/96-1440	109-GR-001-12-13-SS					X	
029936-01	6/04/96-0930	109-GR-002-8-9-SS		X	X			
029936-03	6/04/96-0930	109-GR-002-8-9-SS				X		

TABLE 3-1 (Continued)
ER Site 109: Listing of Samples Collected and Analysis Performed

SAMPLE NUMBER	DATE/TIME SAMPLED	SAMPLE LOCATION	REMARKS	FIELD SCREENING	ON-SITE LAB		OFF-SITE LAB	
				Radiation	Gamma spec.	TAL Metals	High Explosives	TAL Metal
029936-04	6/04/96-0930	109-GR-002-8-9-SS					X	
029937-01	6/04/96-1000	109-GR-002-12-13-SS		X	X			
029937-03	6/04/96-1000	109-GR-002-12-13-SS				X		
029937-04	6/04/96-1000	109-GR-002-12-13-SS					X	
029938-01	6/04/96-1045	109-GR-003-8-9-SS		X	X			
029938-03	6/04/96-1045	109-GR-003-8-9-SS				X		
029938-04	6/04/96-1045	109-GR-003-8-9-SS					X	
029939-01	6/04/96-1115	109-GR-003-12-13-SS		X	X			
029939-03	6/04/96-1115	109-GR-003-12-13-SS				X		
029939-04	6/04/96-1115	109-GR-003-12-13-SS					X	
029940-01	6/04/96-1330	109-GR-004-8-9-SS		X	X			
029940-03	6/04/96-1330	109-GR-004-8-9-SS				X		
029940-04	6/04/96-1330	109-GR-004-8-9-SS					X	
029941-01	6/04/96-1515	109-GR-004-12-13-SS		X	X			
029941-02	6/04/96-1515	109-GR-004-12-13-SS						X
029941-03	6/04/96-1515	109-GR-004-12-13-SS				X		
029941-04	6/04/96-1515	109-GR-004-12-13-SS					X	
029942-01	6/05/96-0930	109-GR-005-8-9-SS		X	X			
029942-03	6/05/96-0930	109-GR-005-8-9-SS				X		
029942-04	6/05/96-0930	109-GR-005-8-9-SS					X	
029943-01	6/05/96-0955	109-GR-005-12-13-SS		X	X			
029943-03	6/05/96-0955	109-GR-005-12-13-SS				X		
029943-04	6/05/96-0955	109-GR-005-12-13-SS					X	
029944-01	6/05/96-1145	109-GR-006-8-9-SS		X	X			
029944-03	6/05/96-1145	109-GR-006-8-9-SS				X		
029944-04	6/05/96-1145	109-GR-006-8-9-SS					X	
029945-01	6/05/96-1345	109-GR-006-12-13-SS		X	X			
029945-02	6/05/96-1345	109-GR-006-12-13-SS						X
029945-03	6/05/96-1345	109-GR-006-12-13-SS				X		

TABLE 3-1 (Continued)
ER Site 109: Listing of Samples Collected and Analysis Performed

SAMPLE NUMBER	DATE/TIME SAMPLED	SAMPLE LOCATION	REMARKS	FIELD SCREENING	ON-SITE LAB		OFF-SITE LAB	
				Radiation	Gamma spec.	TAL Metals	High Explosives	TAL Metal
029945-04	6/05/96-1345	109-GR-006-12-13-SS					X	
029946-01	6/05/96-1445	109-GR-007-8-9-SS		X	X			
029946-03	6/05/96-1445	109-GR-007-8-9-SS				X		
029946-04	6/05/96-1445	109-GR-007-8-9-SS					X	
029947-01	6/05/96-1510	109-GR-007-12-13-SS		X	X			
029947-03	6/05/96-1510	109-GR-007-12-13-SS				X		
029947-04	6/05/96-1510	109-GR-007-12-13-SS					X	
029948-01	6/06/96-0945	109-GR-008-8-9-SS		X	X			
029948-03	6/06/96-0945	109-GR-008-8-9-SS				X		
029948-04	6/06/96-0945	109-GR-008-8-9-SS					X	
029949-01	6/06/96-1200	109-GR-008-12-13-SS		X	X			
029949-02	6/06/96-1200	109-GR-008-12-13-SS						X
029949-03	6/06/96-1200	109-GR-008-12-13-SS				X		
029949-04	6/06/96-1010	109-GR-008-12-13-SS					X	
029950-01	6/06/96-1345	109-GR-009-8-9-SS		X	X			
029950-03	6/06/96-1345	109-GR-009-8-9-SS				X		
029950-04	6/06/96-1345	109-GR-009-8-9-SS					X	
029951-01	6/06/96-1400	109-GR-009-12-13-SS		X	X			
029951-03	6/06/96-1400	109-GR-009-12-13-SS				X		
029951-04	6/06/96-1400	109-GR-009-12-13-SS					X	
029952-01	6/06/96-1415	109-GR-010-8-9-SS		X	X			
029952-03	6/06/96-1415	109-GR-010-8-9-SS				X		
029952-04	6/06/96-1415	109-GR-010-8-9-SS					X	
029953-01	6/06/96-1430	109-GR-010-12-13-SS		X	X			
029953-02	6/06/96-1430	109-GR-010-12-13-SS					X	
029953-03	6/06/96-1430	109-GR-010-12-13-SS				X		
029953-04	6/06/96-1430	109-GR-010-12-13-SS						X
029958-01	6/06/96-1515	109-GR-011-8-9-SS		X	X			
029958-03	6/06/96-1515	109-GR-011-8-9-SS				X		

TABLE 3-1 (Continued)
ER Site 109: Listing of Samples Collected and Analysis Performed

SAMPLE NUMBER	DATE/TIME SAMPLED	SAMPLE LOCATION	REMARKS	FIELD SCREENING	ON-SITE LAB		OFF-SITE LAB	
				Radiation	Gamma spec.	TAL Metals	High Explosives	TAL Metal
029958-04	6/06/96-1515	109-GR-011-8-9-SS					X	
029959-01	6/10/96-1000	109-GR-011-12-13-SS		X	X			
029959-03	6/10/96-1000	109-GR-011-12-13-SS				X		
029959-04	6/10/96-1000	109-GR-011-12-13-SS					X	
029960-01	6/10/96-1100	109-GR-012-8-9-SS		X	X			
029960-03	6/10/96-1100	109-GR-012-8-9-SS				X		
029960-04	6/10/96-1100	109-GR-012-8-9-SS					X	
029961-01	6/10/96-1115	109-GR-012-12-13-SS		X	X			
029961-02	6/10/96-1115	109-GR-012-12-13-SS						X
029961-03	6/10/96-1115	109-GR-012-12-13-SS				X		
029961-04	6/10/96-1115	109-GR-012-12-13-SS					X	
029962-01	6/10/96-1345	109-GR-013-8-9-SS		X	X			
029962-03	6/10/96-1345	109-GR-013-8-9-SS				X		
029962-04	6/10/96-1345	109-GR-013-8-9-SS					X	
029963-01	6/11/96-1130	109-GR-013-12-13-SS		X	X			
029963-03	6/11/96-1130	109-GR-013-12-13-SS				X		
029963-04	6/11/96-1130	109-GR-013-12-13-SS					X	
029718-01	6/11/96-1340	109-GR-014-8-9-SS		X	X			
029718-03	6/11/96-1340	109-GR-014-8-9-SS				X		
029718-04	6/11/96-1340	109-GR-014-8-9-SS					X	
029719-01	6/11/96-1400	109-GR-014-12-13-SS		X	X			
029719-02	6/11/96-1400	109-GR-014-12-13-SS						X
029719-03	6/11/96-1400	109-GR-014-12-13-SS				X		
029719-04	6/11/96-1400	109-GR-014-12-13-SS					X	
029720-01	6/11/96-1445	109-GR-015-4-5-SS		X	X			
029720-03	6/11/96-1445	109-GR-015-4-5-SS				X		
029720-04	6/11/96-1445	109-GR-015-4-5-SS					X	
029721-01	6/11/96-1500	109-GR-015-7-8-SS		X	X			
029721-03	6/11/96-1500	109-GR-015-7-8-SS				X		

TABLE 3-1 (Concluded)
ER Site 109: Listing of Samples Collected and Analysis Performed

SAMPLE NUMBER	DATE/TIME SAMPLED	SAMPLE LOCATION	REMARKS	FIELD SCREENING	ON-SITE LAB		OFF-SITE LAB	
				Radiation	Gamma spec.	TAL Metals	High Explosives	TAL Metal
029721-04	6/11/96-1500	109-GR-015-7-8-SS					X	
Field Blank:								
029954-01	6/04/96-1542	109-GR-04-FB	Deionized Water		X			
029956-02	6/04/96-1535	109-GR-04-FB	Deionized Water					X
029954-04	6/04/96-1535	109-GR-04-FB	Deionized Water				X	
Equipment Blank:								
029955-01	6/04/96-1542	109-GR-04-EB	Deionized Water		X			
029957-02	6/04/96-1540	109-GR-04-EB	Deionized Water					X
029955-04	6/04/96-1540	109-GR-04-EB	Deionized Water				X	

collected and sent to the on-site laboratory for gamma spectroscopy and TAL metals analysis. Thirty-one subsurface and eleven surface soil samples were collected and sent to the off-site laboratory for HE analyses. Eight subsurface duplicate soil samples and three surface duplicate soil samples were collected and sent to the off-site laboratory for TAL metals analysis (confirmation of the on-site laboratory analyses). The data quality objective of 100 percent on-site laboratory analysis with 20 percent off-site laboratory analysis for confirmation was met for this site.

All of the surface and subsurface sample locations were surveyed with Global Positioning System equipment. The survey data include northing and easting coordinates for each sample location.

3.2.4.4 Sample Packaging and Shipping

Soil samples sent to the on-site and off-site laboratories for HE and TAL metals analyses were collected in 250 milliliter containers (either CAB sleeves or bottles). Soil samples sent to the on-site laboratory for gamma spectroscopy analysis were collected in 500 milliliter Marinelli jars. The CAB sleeves and bottles were labeled, sealed with custody tape, and placed in a protective bubble-wrap bag, prior to shipment or transport to the laboratory.

The gamma spectroscopy (on-site laboratory) and HE and TAL metals (off-site laboratory) samples were delivered to the SNL/NM Sample Management Office (SMO). SMO personnel performed cross-checking of the information on the sample labels against the data on the Analysis Request and Chain of Custody, and prepared samples for shipment. The HE and TAL metals samples were shipped by overnight delivery to General Engineering Laboratories in Charleston, South Carolina. The gamma spectroscopy samples were screened then delivered to the on-site laboratory on the same day as received by SMO.

The remaining TAL metals samples were sent directly to the on-site laboratory for analyses.

3.2.4.5 Data Management

Data management for the off-site laboratory analytical data was coordinated through the SMO project coordinator. Upon sample shipment to the off-site laboratory, sample information was entered into a database to track the status of each sample. Upon completion of the laboratory analyses, SMO received analytical results in a summary data report (Certificate of Analysis Reports) and laboratory quality control (QC) report. The on-site laboratory analytical data was managed by the laboratory manager.

The Certificate of Analysis and the on-site laboratory reports were reviewed by IT Corporation for completeness and accuracy as required by SNL/NM Technical Operating Procedures 94-03 (SNL/NM 1994d). Data validation was performed using SNL/NM Data Verification/Validation Level 1 (DV1) and Level 2 (DV2) checklists.

3.2.4.6 *Analytical Data Summary*

This section discusses the analytical methods and the analytical results for the surface and subsurface soil samples.

Analytical Methods

All soil samples were field screened for radiation using either a beta-gamma pancake probe and/or sodium iodide scintillometer. Gamma spectroscopy samples were analyzed following SNL/NM-approved analytical procedures by the on-site laboratory. Samples sent to the on-site laboratory were analyzed by the inductively couple plasma method for TAL metals. Samples sent to the off-site laboratory were analyzed by U.S. Environmental Protection Agency (EPA) methods: Method 6010/7000 for TAL metals and Method 8330 for HE.

Analytical results for inorganic compounds listed "J" values for some compounds. A "J" indicates an estimated value for a compound detected at a level less than the reporting limit but greater than the method detection limit. Data results flagged as "J" values are included in the data summary tables used in this report; however, because "J" values may represent false-positive concentrations, care should be used when evaluating these analytical results.

Surface Soil Sample Results

The analytical results for the Site 109 surface soil samples were as follows:

- The pancake probe readings (field screening) were within normal background levels of 80 to 120 counts per minute (Mignardot 1996b). Since the readings were within background levels, no additional samples were sent to the laboratory for isotopic uranium analysis per the sampling plan.

- On-site laboratory gamma spectroscopy results were within normal background levels (Brown 1996). The complete analytical results and review are provided in Section 6.1.

- The off-site laboratory HE results were non-detect for all samples (including QC samples). The complete analytical data packages are located in the SNL/NM Environment, Safety, and Health (ES&H) Record Center.

- The on-site laboratory analytical results were non-detect for the following metals: antimony, arsenic, beryllium, chromium, cobalt, lead, nickel, selenium, and vanadium. Metals detected by the on-site laboratory that are above SNL/NM background levels (Southwest Group) and/or Subpart S action levels, and site COCs are summarized in Table 3-2. Metals detected by the off-site laboratory that are above SNL/NM background levels (Southwest Group) and/or Subpart S action levels and site COCs are summarized in Table 3-3. A complete discussion of the metal results is provided in Section 3.2.4.8.

TABLE 3-2

ER Site 109: Summary of TAL Metals Results for Surface Soil Samples, June 1996.
(On-Site Laboratory only)

Sample Attributes			TAL Metals, Method 6010/7000 (mg/kg)				
Sample Number	ER Sample ID	Sample Depth (in.)	Al	Be	Cd	Cu	Pb
029722-03	109-GR-001-0-6-SS	0-6	2500	ND	ND	ND	ND
029724-03	109-GR-002-0-6-SS	0-6	4000	ND	ND	46 J	ND
029725-03	109-GR-003-0-6-SS	0-6	4000	ND	ND	210	ND
029726-03	109-GR-004-0-6-SS	0-6	3200	ND	99	560	ND
029727-03	109-GR-005-0-6-SS	0-6	4700	ND	ND	38 J	ND
029728-03	109-GR-006-0-6-SS	0-6	6500	ND	ND	ND	ND
029729-03	109-GR-007-0-6-SS	0-6	4500	ND	ND	ND	ND
029730-03	109-GR-008-0-6-SS	0-6	5200	ND	ND	ND	ND
029731-03	109-GR-009-0-6-SS	0-6	7200	ND	ND	ND	ND
029732-03	109-GR-010-0-6-SS	0-6	8700 J	ND	ND	ND	ND
Method Detection Limit			20	0.11	2.1	20	3.4
Site-Wide Background UTL/95th Percentile (Southwest Group)[a]			NA	0.65	1.6	15.4	21.4

[a]UTL/95th *Percentile values taken from* SNL/NM *sitewide background report* (IT *Corporation* 1996).

Notes: **mg/kg** - milligrams per kilogram; **J** - concentration below the practical quantitation limit; **ND** - not detected at the method detection limit; **NA** - not applicable; **TAL** - target analyte list; **UTL** - upper tolerance limit

Metals: **Al** - aluminum; **Be** - beryllium; **Cd** - cadmium; **Cu** - copper; **Pb** - lead

TABLE 3-3

ER Site 109: Summary of TAL Metals Results for Surface Soil Samples, June 1996.

(Off-Site Laboratory only)

Sample Attributes			TAL Metals, Method 6010/7000 (mg/kg)				
Sample Number	ER Sample ID	Sample Depth (in.)	Al	Be	Cd	Cu	Pb
029723-02	109-GR-001-0-6-SSD	0-6	3390 B	0254 J	1.14	41.3	9.37 B
029724-02	109-GR-002-0-6-SS	0-6	4010 B	0.304 J	2.62	55.7	10.1 B
029728-02	109-GR-006-0-SS	0-6	6780 B	0.466 J	0.332 J	8.34	8.46 B
Method Detection Limit			1.18	0.001	0.009	0.05	0.11
Site-Wide Background UTL/95th Percentile (Southwest Group)[a]			NA	0.65	1.6	15.4	21.4
Quality Assurance/Quality Control Samples (mg/l)							
029733-02	109-GR-010-FB	NA	0.036 JB	ND	ND	0.0027 J	ND
034001-02	109-GR-010-EB	NA	0.053 B	ND	0.00018 JB	0.0032 J	ND
Method Detection Limit (mg/l)			0.0119	0.00001	0.00009	0.000539	0.00113

[a]UTL/95th Percentile values taken from SNL/NM sitewide background report (IT Corporation 1996).

Notes: **mg/kg** - milligrams per kilogram; **mg/l** - milligrams per liter; **B** - detected in the laboratory method blank; **J** - concentration below the practical quantitation limit; **ND** - not detected at the method detection limit; **NA** - not applicable; **TAL** - target analyte list; **UTL** - upper tolerance limit.

Metals: **Al** - aluminum; **Be** - beryllium; **Cd** - cadmium; **Cu** - copper; **Pb** - lead.

Subsurface Soil Sample Results

The analytical results for Site 109 subsurface soil samples were as follows:

- The pancake probe readings (field screening) were within normal background levels of 80 to 120 counts per minute (Mignardot 1996b). Since the readings were within background levels, no additional samples were sent to the laboratory for isotopic uranium analysis per sampling plan.

- On-site laboratory gamma spectroscopy results were within normal background levels (Brown 1996). The complete analytical data package and review are provided in Section 6.1.

- The off-site laboratory HE results were non-detect for all samples (including QC samples). The complete analytical data packages are located in the SNL/NM ES&H Record Center.

- The on-site laboratory analytical results were non-detect for the following metals: antimony, arsenic, cobalt, copper, and selenium. Metals detected by the on-site laboratory that are above SNL/NM background levels (Southwest Group) and/or Subpart S action levels and site COCs are summarized in Table 3-4. Metals detected by the off-site laboratory that are above SNL/NM background levels (Southwest Group) and/or Subpart S action levels and site COCs are summarized in Table 3-5. A complete discussion of the metal results is provided in Section 3.2.4.8.

3.2.4.7 *Quality Assurance/Quality Control Results*

This subsection discusses the field and laboratory quality assurance/quality control results.

Field Quality Control Samples

Three types of field QC samples (Table 3-1) were shipped for analyses during the field investigation: field duplicate soil samples, field blank water samples, and equipment blank rinsate samples. No additional soils were collected for matrix spike/matrix spike duplicate (MS/MSD) analyses.

Two field duplicate soil samples were collected and composited, then split into the original and duplicate samples. The duplicates were analyzed for HE only. The two duplicates were non-detect for all HE compounds. Additional soil samples were not collected and analyzed for TAL metals or gamma spectroscopy.

Two equipment blank rinsate samples were collected from deionized water poured over the equipment after decontamination of the sampling equipment. The samples were analyzed for HE, TAL metals, and gamma spectroscopy. The samples were non-detect for HE, below background levels for gamma spectroscopy, and either non-detect and/or very low concentrations for metals.

TABLE 3-4
ER Site 109: Summary of TAL Metals Results for Subsurface Soil Samples, June 1996
(On-Site Laboratory only)

Sample Attributes			TAL Metals, Method 6010/7000 (mg/kg)						
Sample Number	ER Sample ID	Sample Depth (ft)	Al	Be	Co	Cr	Cu	Pb	Th
029933-03	109-GR-001-8-9-SS	8-9	3000	ND	ND	ND	ND	ND	NA
029935-03	109-GR-001-12-13-SS	12-13	2800	ND	ND	ND	ND	ND	NA
029936-03	109-GR-002-8-9-SS	8-9	3600	ND	ND	ND	ND	ND	NA
029937-03	109-GR-002-12-13-SS	12-13	8500 J	ND	ND	ND	ND	ND	NA
029938-03	109-GR-003-8-9-SS	8-9	2600	ND	ND	ND	ND	ND	NA
029939-03	109-GR-003-12-13-SS	12-13	5500	ND	ND	ND	ND	ND	NA
029940-03	109-GR-004-8-9-SS	8-9	2900	ND	ND	ND	ND	ND	NA
029941-03	109-GR-004-12-13-SS	12-13	3800	ND	ND	ND	ND	ND	NA
029942-03	109-GR-005-8-9-SS	8-9	3900	ND	ND	10[b]	ND	8.4 J[b]	NA
029943-03	109-GR-005-12-13-SS	12-13	5400	ND	ND	12[b]	ND	8.5 J[b]	NA
029944-03	109-GR-006-8-9-SS	8-9	4300	ND	ND	11[b]	ND	15[b]	NA
029945-03	109-GR-006-12-13-SS	12-13	4000	ND	ND	9.7[b]	ND	11 J[b]	NA
029946-03	109-GR-007-8-9-SS	8-9	4600	ND	ND	12[b]	ND	13[b]	NA
029947-03	109-GR-007-12-13-SS	12-13	3800	ND	ND	16[b]	ND	18[b]	NA
029948-03	109-GR-008-8-9-SS	8-9	4900	ND	ND	11[b]	ND	5 J[b]	NA
029949-03	109-GR-008-12-13-SS	12-13	4600	ND	ND	20[b]	ND	12[b]	NA
029950-03	109-GR-009-8-9-SS	8-9	4200	ND	ND	10[b]	ND	7 J[b]	NA
029951-03	109-GR-009-12-13-SS	12-13	5400	ND	ND	13[b]	ND	7.2 J[b]	NA
029952-03	109-GR-010-8-9-SS	8-9	3600	ND	ND	39[b]	ND	7.5 J[b]	NA
029953-03	109-GR-010-12-13-SS	12-13	3900	ND	ND	9.7[b]	ND	7.7 J[b]	NA
029958-03	109-GR-011-8-9-SS	8-9	4200	ND	ND	12[b]	ND	9.5[b]	NA
029959-03	109-GR-011-12-13-SS	12-13	3600	ND	ND	ND	ND	ND	NA
029960-03	109-GR-012-8-9-SS	8-9	5200	ND	ND	ND	ND	ND	NA
029961-03	109-GR-012-12-13-SS	12-13	4300	0.26 J	ND	ND	ND	ND	NA
029962-03	109-GR-013-8-9-SS	8-9	3900	0.56	ND	ND	ND	ND	NA
Method Detection Limit			20	0.11	1.3-10	5	0.6-20	3.4	NA

TABLE 3-4 (Concluded)
ER Site 109: Summary of TAL Metals Results for Subsurface Soil Samples, June 1996
(On-Site Laboratory only)

Sample Attributes			TAL Metals, Method 6010/7000 (mg/kg)						
Sample Number	ER Sample ID	Sample Depth (ft)	Al	Be	Co	Cr	Cu	Pb	Th
Site-Wide Background UTL/95th Percentile (Southwest Group)[a]			NA	0.65	5.2	15.9	18.2	11.8	<1.1
029963-03	109-GR-013-12-13-SS	12-13	3200	ND	ND	ND	ND	ND	NA
029718-03	109-GR-014-8-9-SS	8-9	4300	ND	ND	350	ND	ND	NA
029719-03	109-GR-014-12-13-SS	12-13	3500	ND	ND	22	ND	ND	NA
029720-03	109-GR-015-4-5-SS	4-5	1200	ND	ND	ND	ND	ND	NA
029721-03	109-GR-015-7-8-SS	7-8	3900	ND	ND	ND	ND	ND	NA
Method Detection Limit			20	0.11	1.3-10	5	0.6-20	3.4	NA
Site-Wide Background UTL/95th Percentile (Southwest Group)[a]			NA	0.65	5.2	15.9	18.2	11.8	<1.1

[a]UTL/95th Percentile values taken from SNL/NM sitewide background report (IT Corporation 1996).
[b]Method Detection Limits (MDL) for Cr is 1.8 mg/kg and for Pb is 2.4 mg/kg.
Notes: mg/kg - milligrams per kilogram; **J** - concentration below the practical quantitation limit; **ND** - not detected above the MDL; **NA** - not analyzed; **TAL** - target analyte list; **UTL** - upper tolerance limit.
Metals: Al - aluminum; **Be** - beryllium; **Co** - cobalt; **Cr** - chromium; **Cu** - copper; **Pb** - lead; **Th** - thallium.

TABLE 3-5

ER Site 109: Summary of TAL Metals Results for Subsurface Soil Samples, June 1996

(Off-Site Laboratory only)

Sample Attributes			TAL Metals, Method 6010/7000 (mg/kg)						
Sample Number	ER Sample ID	Sample Depth (ft.)	Al	Be	Cr	Co	Cu	Pb	Th
029934-02	109-GR-001-8-9-SSD	8-9	4070	0.286 JB	6.29 B	3.77 B	6.94	4.91	3.22
029937-02	109-GR-001-12-13-SS	12-13	6220	0.2 JB	17.9 B	11.5 B	40.4	3.28	7.9
029941-02	109-GR-004-12-13-SS	12-13	5690	0.331 JB	7.76 B	4.82 B	7.67	5.49	3.5
029945-02	109-GR-006-12-13-SS	12-13	6200 B	0.192 JB	8.05 B	6.33	22.2	3.52 B	8.79
029949-02	109-GR-008-12-13-SS	12-13	2650 B	0.197 J	48.6 B	2.72	8.53	4.58 B	0.851 J
029953-04	109-GR-010-12-13-SS	12-13	5930 B	0.401 J	5.28 B	2.86	4.86	5.21 B	ND
029961-02	109-GR-012-12-13-SS	12-13	1740 B	0.127 J	5.56 B	1.44	5.35	3.1 B	0.937 J
029719-02	109-GR-014-12-13-SS	12-13	3150 B	0.213 J	4.67 B	3.01	8.74	3.93 B	1.82
Method Detection Limit (Range)			1.14-1.18	0.0011-0.00113	0.573-0.59	0.0169-0.0174	0.0267-0.0534	0.109-0.112	0.199-0.205
Site-Wide Background UTL/95th Percentile (Southwest Group)[a]			NA	0.65	15.9	5.2	18.2	11.8	<1.1
Quality Assurance/Quality Control Samples (mg/l)									
029956-02	109-GR-04-FB	NA	0.023 JB	ND	ND	ND	0.001 J	ND	ND
029957-02	109-GR-04-EB	NA	0.57 B	ND	0.0027 J	ND	0.0057 J	ND	ND
Method Detection Limit (mg/l)			0.0119	0.00001	0.0006	0.0002	0.00054	0.0011	0.0021

[a]UTL/95th Percentile values taken from SNL/NM sitewide background report (IT Corporation 1996).

Notes: **mg/kg** - milligrams per kilogram; **mg/l** - milligrams per liter; **J** - concentration below the practical quantitation limit; **B** - analyte detected in the laboratory method blank; **ND** - not detected in the method detection limit; **NA** - not applicable; **TAL** - target analyte list; **UTL** - upper tolerance limit.

Metals: **Al** - aluminum; **Be** - beryllium; **Co** - cobalt; **Cr** - chromium; **Cu** - copper; **Pb** - lead; **Th** - thallium;

Two field blank water (deionized) samples were exposed (open jar) to atmospheric conditions around the drilling/sampling operation and analyzed for HE and TAL metals. In addition, gamma spectroscopy analyses were performed on these two samples. Field blank samples are only collected and analyzed when sampling for volatile organic compounds (VOC). These two samples were not required, as VOCs were not included on the COC list for this site.

Data Validation Results

An analytical data review was performed to ensure that the DV1 and DV2 reviews are accurate and the data are acceptable for use in NFA reports. The report is provided in Section 6.2. In summary, the review indicates that DV1 and DV2 findings are acceptable for the NFA report.

The analytical quality of the Level 3 (off-site laboratory) metals data is excellent except for antimony, barium, iron, potassium, and sodium. Although these five metals are either outside MS/MSD analyte recovery values and/or the laboratory control sample/laboratory control sample duplicate recovery values, there is no significant impact to data quality. There is generally good agreement between the Level 2 (on-site laboratory) and Level 3 (off-site laboratory) metal data.

Level 3 HE analytical data are generally good and are acceptable for this NFA report.

3.2.4.8 Data Evaluation

The data evaluation discussion is limited to the metals. The gamma spectroscopy analytical results were within normal background levels and the HE results were non-detect for all samples. Based on these reasons, no evaluations were completed for radionuclides and HE.

Metal analytical results were compared to the site-wide background study for SNL/NM (IT Corporation 1996) and proposed RCRA Subpart S action levels for soils (EPA 1990). For updated soil action levels, some values (i.e., zinc) were taken from the "Report of Generic Action Level Assistance for the Sandia National Laboratories/New Mexico Environmental Restoration Program" (IT Corporation 1994). The generic values from this report were made current for guidance through June 1994, according to proposed RCRA Subpart S methods.

Surface Soil Evaluation

The results of the on-site and off-site TAL metals analytical results for surface soil sampling are presented in Table 3-6. The table shows the range of concentrations for each specific metal for both the on-site and off-site laboratories, the number of samples (analyzed on-site and off-site), the SNL/NM background concentration, and the proposed RCRA Subpart S action level for soils. The concentrations of all metals (on-site and off-site) are within SNL/NM background levels and/or Subpart S action levels except for aluminum, cadmium, calcium, copper, iron, magnesium, potassium, and sodium. Although calcium, iron, magnesium, potassium, and sodium were above SNL/NM background levels (or no background levels were available), these chemicals are considered essential nutrients (EPA 1989) and are not COCs

TABLE 3-6

ER Site 109: Metal Data Comparison for Surface Soil Samples with SNL/NM Background Levels and Subpart S Action Levels

Compound	Number of Samples (On-Site)	Site 109 On-Site Laboratory Analytical Results Range of Values (mg/kg)	Number of Samples (Off-Site)	Site 109 Off-Site Laboratory Analytical Results Range of Values (mg/kg)	Site-Wide Background UTL/95th Percentile (mg/kg)	Subpart S Action Level (mg/kg)
Aluminum	10	2,500-8,700 (J)	3	3,390 (B)-6,780 (B)	NA	NA
Antimony	10	ND	3	0.133 (J)-0.215 (J)	3.9	30
Arsenic	10	ND	3	1.62-2.44	5.6	0.5
Barium	10	130-630	3	90 (B)-174	130	4,000
Beryllium	10	ND	3	0.254 (J)-0.466 (J)	0.65	0.2
Cadmium	10	ND-99	3	0.332 (J)-2.62	1.6	40
Calcium	10	3,000-7,500	3	4,070 (B)-6,480 (B)	NA	NA
Chromium	10	ND	3	4.63 (B)-6.68 (B)	17.3	NA
Cobalt	10	ND	3	2.32-3.62	5.2	NA
Copper	10	ND-560	3	8.34-55.7	15.4	NA
Iron	10	5,400 (J)-9,900 (J)	3	5,210 (B)-7,440 (B)	NA	NA
Lead	10	ND	3	8.46 (B)-10.1 (B)	21.4	400[a]
Magnesium	10	1,000-2,600	3	1,410 (B)-2,380 (B)	NA	NA
Manganese	10	22 (J)-78	3	121 (B)-155 (B)	NA	10,000[b]
Mercury	10	NA	3	0.009 (J)-0.0158 (J)	0.31	20
Nickel	10	ND	3	4.64 (B)-8.41 (B)	11.5	2,000
Potassium	10	NA	3	1190-1720	NA	NA
Selenium	10	ND	3	ND-0.157	<1	400[b]
Silver	10	ND-8.3	3	ND-1.06	2	200
Sodium	10	NA	3	30.2 (B)-37.9 (B)	NA	NA
Thallium	10	NA	3	0.537 (J)-0.658 (J)	<1.1	NA
Vanadium	10	ND	3	9.76-12.3	20.4	600[b]
Zinc	10	ND-31 (J)	3	23.9 (B)-37.6 (B)	62	20,000[b]

[a] The action level for lead is provided from U.S. Environmental Protection Agency, 1994. "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities," PB94-963282, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

[b] The action levels are provided from "Report of Generic Action Level Assistance for the Sandia National Laboratory/New Mexico Environmental Restoration Program," 1994, prepared by IT Corporation, Albuquerque, New Mexico.

mg/kg = milligrams per kilogram.
ND = Not detected.
NA = Not available.

for this site. In addition, arsenic and beryllium were detected below SNL/NM background levels, but above the proposed RCRA Subpart S action level for soils. Arsenic and beryllium occur at higher concentrations naturally in the soils within this geologic region and should not be considered COCs for this site. Based on data evaluation and risk assessment criteria, aluminum, cadmium, and copper provide the basis for conducting a risk assessment analysis for ER Site 109.

Subsurface Soil Evaluation

The results of the on-site and off-site TAL metals analytical results for Site 109 subsurface soil samples are presented in Table 3-7. The table shows the range of concentrations for each specific metal for both the on-site and off-site laboratories, the number of soil samples (analyzed on-site and off-site), the SNL/NM background concentration, and the proposed RCRA Subpart S action level for soils. The concentrations of all metals (on-site and off-site) are within SNL/NM background levels and/or Subpart S action levels except for aluminum, calcium, chromium, cobalt, copper, iron, magnesium, potassium, sodium, and thallium. Although calcium, iron, magnesium, potassium, and sodium were above SNL/NM background levels (or no background levels were available), these chemicals are considered essential nutrients (EPA 1989) and are not COCs for this site. In addition, arsenic and beryllium were detected below background levels, but above the proposed RCRA Subpart S action level for soils. Arsenic and beryllium occur at higher concentrations naturally in the soils within this geologic region and should not be considered COCs for this site. Based on data evaluation and risk assessment criteria, aluminum, chromium, and copper provide the basis for conducting a risk assessment analysis for ER Site 109.

3.3 Gaps in Information

The UXO/HE survey, as well as surface and subsurface soil sampling, addressed data gap issues that arose based on employee interviews, historical use of the area, and process knowledge of the site. No live and/or significant UXO/HE debris was found and no gamma activity 30 percent or greater than the natural background levels was found at the site. The confirmatory sampling program provided the sampling, analyses, and evaluation of data for the two potential impact areas around Building 9950. Based on the confirmatory sampling program, all data gap issues were addressed in the field and in this report.

3.4 Risk Analysis

The following subsections summarize the results of the risk assessment process for both human and ecological risk related factors. The complete risk assessment report is provided in Section 6.3.

TABLE 3-7
ER Site 109: Metal Data Comparison for Subsurface Soil Samples with SNL/NM Background Levels and Subpart S Action Levels

Compound	Number of Samples (On-Site)	Site 109 On-Site Laboratory Analytical Results Range of Values (mg/kg)	Number of Samples (Off-Site)	Site 109 Off-Site Laboratory Analytical Results Range of Values (mg/kg)	Site-Wide Background UTL/95th Percentile (mg/kg)	Subpart S Action Level (mg/kg)
Aluminum	30	1,200-8,500 (J)	8	1,740 (B)-6,220	NA	NA
Antimony	30	ND	8	ND-0.353 (J)	3.9	30
Arsenic	30	ND	8	0.992-3.28	4.4	0.5
Barium	30	53-350	8	22.2 (B)-207 (B)	214	4,000
Beryllium	30	ND-0.56	8	0.127 (J)-0.401 (J)	0.65	0.2
Cadmium	30	ND	8	ND-0.104 (J)	0.9	40
Calcium	30	3,900-21,0000	8	22,600 (B)-147,000 (B)	NA	NA
Chromium	30	ND-350	8	4.67 (B)-48.6 (B)	15.9	NA
Cobalt	30	ND	8	1.44-11.5 (B)	5.2	NA
Copper	30	ND	8	4.86-40.4	18.2	NA
Iron	30	4,200-40,000 (J)	8	3,500 (B)-13,700 (B)	NA	NA
Lead	30	ND-18	8	3.1 (B)-5.49	11.8	400[a]
Magnesium	30	680-5,100	8	2,200 (B)-5,950 (B)	NA	NA
Manganese	30	20 (J)-240	8	85.8 (B)-261 (B)	NA	10,000[b]
Mercury	30	NA	8	ND-0.004 (J)	<0.1	20
Nickel	30	ND-49	8	4.04 (B)-13.1 (B)	11.5	2,000
Potassium	30	NA	8	310-1,580	NA	NA
Selenium	30	ND	8	ND-0.39 (J)	<1	400[b]
Silver	30	ND-5.7	8	ND	<1	200
Sodium	30	NA	8	169 (B)-678 (B)	NA	NA
Thallium	30	NA	8	ND-8.79	<1.1	NA
Vanadium	30	ND-18 (J)	8	5.51-32 (B)	21.5	600[b]
Zinc	30	ND-47	8	6.22 (B)-32.2 (B)	62	20,000[b]

[a] The action level for lead is provided from U.S. Environmental Protection Agency, 1994. "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities," PB94-963282, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

[b] The action levels are provided from "Report of Generic Action Level Assistance for the Sandia National Laboratory/New Mexico Environmental Restoration Program," 1994, prepared by IT Corporation, Albuquerque, New Mexico.

mg/kg = Milligrams per kilogram.
ND = Not detected.
NA = Not available.

3.4.1 Human Health Risk Assessment

ER Site 109 has been recommended for industrial land use (DOE 1996b). Based on data evaluation (Section 3.2.4.8), a risk assessment analysis was completed because certain COC results indicated concentrations above SNL/NM background and/or proposed RCRA Subpart S action levels for soils. The risk assessment report provides a quantitative evaluation of the potential adverse human health effects caused by constituents of concern (COC) in the site's soil. The report calculated the hazard index and excess cancer risk for both industrial land-use and residential land-use (requested by the New Mexico Environment Department [NMED]) scenarios.

In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. Maximum concentrations reported from the on-site and off-site laboratories surface and subsurface soil samples were combined into a single table to provide conservative risk calculations.

In summary, the hazard index calculated for the site COCs is 0.4, and the incremental hazard index is 0.37 for an industrial land-use setting, which is much less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). The cancer risk for the site COCs is 2.5×10^{-5}, and the incremental cancer risk is 1.7×10^{-5} for an industrial land-use setting, which is in the middle of the suggested range of acceptable risk of 10^{-6} and 10^{-4} (EPA 1989).

The uncertainties associated with the risk assessment calculations are considered small relative to the conservativeness of the risk assessment analysis. It is therefore concluded, based upon the risk assessment analysis, that ER Site 109 does not have significant potential to affect human health under an industrial land-use scenario.

3.4.2 Ecological Risk Assessment

The ecological risk assessment process is a screening level assessment. The assessment utilizes conservatism in the estimation of ecological risks. Potential risks were indicated for all three receptors (plant, deer mouse, and burrowing owl); however, the use of the maximum measured soil concentration or maximum detection limit to evaluate risk provided the "worst case" scenario for this assessment and may not reflect actual site conditions. However, based on further evaluation of detection limits, comparisons to background concentrations, toxicity benchmark values, and analytical data sets, it is concluded that ecological risks associated with ER Site 109 are insignificant.

4.0 RATIONALE FOR RISK-BASED NFA DECISION

Fourteen soil boring locations were drilled and sampled in the area of the test pits south/southeast of Building 9950. An additional subsurface soil sample was collected at the location of the steel cylinder. Analytical results (on-site and off-site) for soil samples collected during drilling showed no HE or radionuclide contamination, but some TAL metals were detected either above SNL/NM background levels, proposed RCRA Subpart S action levels, and/or laboratory reporting limits.

Ten surface soil samples were collected from the area around the test pad on top of the earthen-covered Building/bunker 9950, and at the base of the berm on the south side of Building/bunker 9950. Analytical results (on-site and off-site) for the surface soil samples showed no HE or radionuclide contamination, but some TAL metals were detected either above SNL/NM background levels, proposed RCRA Subpart S action levels, and/or laboratory reporting limits.

Based on the field investigation data and the human health and ecological risk assessments, an NFA determination is being recommended for Site 109 for the following reasons:

- No radioactivity above background levels was detected during the field screening program.
- Gamma spectroscopy results were within background levels.
- No explosive residue was detected in any of the soil samples.
- No TAL metals (including the COCs lead and beryllium) were present in concentrations considered hazardous to human health for an industrial land-use setting.
- The screening level assessment concluded that ecological risks associated with the site are insignificant.

Upon the evidence cited above, ER Site 109 is being proposed for an NFA based on Criterion 5: The potential release site has been characterized in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land-use.

5.0 REFERENCES

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6.0 ANNEXES

6.1 Gamma Spectroscopy Results and Review

6.2 Data Validation Report

6.3 Risk Assessment Report

Section 6.3
Risk Assessment Report

ER SITE 109: RISK ASSESSMENT ANALYSIS

I. Site Description and History

Site 109 is the Building 9950 Firing Site, and is included in Operable Unit 1335 (Southwest Test Area). The site is located in the North Thunder Range, 0.4 miles east of Technical Area III and approximately 6000 feet west of Lovelace Road. The site covers approximately 0.27 acres. The site was operational from 1963 to approximately 1969. Explosive tests were conducted at two locations: one location was south and/or southeast of Building 9950 and the other was on top the earth-bermed building. The explosives used include baratol, trinitrotoluene (TNT), Composition B, Boracitol, plastic-bonded hexahydro-1,3,5-trinitro-1,3,5-trazine (RDX), nitroguanadine, detasheet and cord. The potential constituents of concerns (COCs) are high explosives (HE), depleted uranium (DU), RCRA metals, aluminum, copper, and beryllium.

II. Human Health Risk Assessment Analysis

Risk assessment of this site includes a number of steps which culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed include:

Step 1.	Site data are described which provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways by which a representative population might be exposed to the COCs are identified.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The tiered approach includes screening steps, followed by potential intake calculations and a discussion or evaluation of the uncertainty in those calculations. Potential intake calculations are also applied to background screening data.
Step 4.	Data are described on the potential toxicity and cancer effects from exposure to the COCs and associated background constituents and subsequent intake.
Step 5.	Potential toxicity effects (specified as a Hazard Index) and cancer risks are calculated for COCs and background.
Step 6.	These values are compared with standards established by the United States (U.S.) Environmental Protection Agency (USEPA) to determine if further evaluation, and potential site clean-up, is required. COC risk values are also compared to background risk so that an incremental risk may be calculated.
Step 7.	Discussion of uncertainties in the previous steps.

II.1 Step 1. Site Data

Site history and characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine the concentration levels of those COCs across the site are described in the ER Site 109 No Further Action Proposal (NFA). In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. Maximum concentrations reported from the onsite and offsite laboratories; subsurface and surface samples were combined into a single table to provide conservative risk calculations. The minimum UTL or 95th percentile, as appropriate, was selected to provide the background screen in Table 1 and to be used to calculate risk attributable to background in Table 4. Chemicals that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment (USEPA 1989). Only nonradioactive COCs are evaluated because all radiologicals were detected within normal background levels. The nonradioactive COCs evaluated are metals and explosives.

II.2 Step 2. Pathway Identification

ER Site 109 has been designated with a future land-use scenario of industrial (USDOE, 1996)(see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion. The inhalation pathway for chemicals is included because of the potential to inhale dust and volatiles. No contamination at depth was determined and therefore no water pathways to the groundwater are considered. Depth to groundwater at Site 109 is approximately 480 feet below ground surface. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered to not be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

PATHWAY IDENTIFICATION

Chemical Constituents
Soil Ingestion
Inhalation (Dust and volatiles)
Plant uptake (Residential only)

II.3 Steps 3-5. Calculation of Hazard Indices and Cancer Risks

Steps 3 through 5 are discussed in this section. These steps include the discussion of the tiered approach in eliminating potential COCs from further consideration in the risk assessment process and the calculation of intakes from all identified exposure pathways, the discussion of the toxicity information, and the calculation of the hazard indices and cancer risks.

The risks from the COCs at ER Site 109 were evaluated using a tiered approach. First, the maximum concentrations of COCs were compared to the SNL/NM background screening level for this area (IT, 1996). If a SNL/NM specific screening level was not available for a constituent, then a background value was obtained, when possible, from the U.S. Geological Survey (USGS) National Uranium Resource Evaluation (NURE) Program (USGS, 1994).

The maximum concentration of the each COC (surface and subsurface samples combined) was used in order to provide a conservative estimate of the associated risk. If any COCs were above the SNL/NM background screening levels or the USGS background value, all COCs were considered in further risk assessment analyses.

Second, if any COC failed the initial screening step, the maximum concentration for each COC was compared with the relevant action level calculated using methods and equations promulgated in the proposed Resource Conservation and Recovery Act (RCRA) Subpart S (40 CFR Part 264, 1990) and Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989) documentation. If there are 10 or fewer COCs and each has a maximum concentration less than one-tenth of the action level, then the site would be judged to pose no significant health hazard to humans. If there are more than 10 COCs, the Subpart S screening procedure was skipped.

Third, hazard indices and risk due to carcinogenic effects were calculated using Reasonable Maximum Exposure (RME) methods and equations promulgated in RAGS (USEPA, 1989). The combined effects of all COCs in the soils were calculated. The combined effects of the COCs at their respective background concentrations in the soils were also calculated. The most conservative background concentration between SNL/NM surface and subsurface concentration (minimum value of the 95th UTL or percentile concentration value, as applicable) was used in the risk calculation. For toxic compounds, the combined effects were calculated by summing the individual hazard quotients for each COC into a total Hazard Index. This Hazard Index is compared to the recommended standard of 1. For potentially carcinogenic compounds, the individual risks were summed. The total risk was compared to the recommended acceptable risk range of 10^{-4} to 10^{-6}.

II.3.1 Comparison to Background and Action Levels

ER Site 109 COCs (excluding HE) are listed in Table 1. The table shows the associated 95th percentile or UTL background levels (IT, 1996). The SNL/NM background levels have not yet been approved by the USEPA or the NMED but

Table 1. COCs (Excluding HE) at ER Site 109 and Comparison to the Background Screening Values.

COC name	Maximum concentration (mg/kg)	SNL/NM 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
Aluminum	8700 J	69,957^^	Yes
Arsenic	26 ND	4.4	**No**
Barium	630	130	**No**
Beryllium	0.56	0.65	Yes
Cadmium	99	0.9	**No**
Chromium, total*	350	1	**No**
Copper	560	15.4	**No**
Lead	18	11.8	**No**
Mercury	0.0158 J	<0.1	**No^**
Selenium	50 ND	<1	**No^**
Silver	8.3	<1	**No^**

ND - non-detect
^ - uncertainty due to detection limits
* total chromium assumed to be chromium VI (most conservative)
^^ value was obtained from the U.S. Geological Survey (USGS) National Uranium Resource Evaluation (NURE) Program (USGS, 1994).
J - estimated value

are the result of a comprehensive study of joint SNL/NM and U.S. Air Force data from the Kirtland Air Force Base (KAFB). The report was submitted for regulatory review in early 1996. The values shown in Table 1 supersede the background values described in an interim background study report (IT, 1994). Several compounds had maximum measured values greater than background screening levels.

Therefore all COCs were retained for further analysis with the exception of lead. The maximum concentration value for lead is 18 mg/kg. The USEPA intentionally does not provide any toxicological data on lead and therefore no risk parameter values can be calculated. However, EPA guidance for the screening value for lead for an industrial land-use scenario is 2000 mg/kg (EPA, 1996a). The maximum concentration value for lead at this site is less than this screening value and therefore lead is eliminated from further consideration in this risk assessment. Because explosive compounds do not have calculated background values, this screening step was skipped, and all explosives are carried into the risk assessment analyses.

Because several COCs had concentrations greater than their respective SNL/NM background 95th percentile or UTL, the site fails the background screening criteria and all COCs proceed to the proposed Subpart S action level screening procedure. Because the ER Site 109 sample set had more than 10 COCs that continued past the first screening level, the proposed Subpart S screening process was skipped. All remaining COCs must have a Hazard Index value and cancer risk value calculated.

II.3.2 Identification of Toxicological Parameters

Table 2 shows the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs.

II.3.3 Exposure Assessment and Risk Characterization

Section II.3.3.1 describes the exposure assessment for this risk assessment. Section II.3.3.2 provides the risk characterization including the Hazard Index value and the excess cancer risk for the potential COCs and associated background; industrial and residential land-uses.

Table 2. Toxicological Parameter Values for ER Site 109 COCs

COC name	RfD_o (mg/kg/d)	RfD_{inh} (mg/kg/d)	Confidence	Sf_o (kg-d/mg)	Sf_{inh} (kg-d/mg)	Cancer Class ^
Aluminum	1	--	Est.	--	--	--
Arsenic	0.0003	--	M	1.5	15.1	A
Barium	0.07	0.000143	M	--	--	D
Beryllium	0.005	--	L	4.3	8.4	B2
Cadmium	0.0005	0.0000571	H	--	6.3	B1
Chromium, total*	0.005	--	L	--	42	A
Copper	0.04	--	Est.	--	--	D
Mercury	0.0003	0.0000857	M	--	--	D
Selenium	0.005	--	H	--	--	D
Silver	0.005	--	--	--	--	D
2,4,6-Trinitrotoluene	0.0005	--	M	0.03	--	C
2,4-Dinitrotoluene	0.002	--	H	--	--	B2
2,6-Dinitrotoluene	0.001	--	--	--	--	B2
2-Amino-4,6-dinitrotoluene**	--	--	--	0.68	--	--
4-Amino-2,6-dinitrotoluene**	--	--	--	0.68	--	--
Nitrobenzene	0.0005	0.000571	L	--	--	D
RDX	0.003	--	--	0.11	--	--
HMX	0.05	--	--	--	--	--
TETRYL	0.01	--	--	--	--	--
m-Dinitrobenzene	0.0001	--	L	--	--	D
m-Nitrotoluene	0.01	--	--	--	--	--
o-Nitrotoluene	0.01	--	--	--	--	--
p-Nitrotoluene	0.01	--	--	--	--	--
sym-Trinitrobenzene	0.00005	--	--	--	--	--

RfD_o - oral chronic reference dose in mg/kg-day
RfD_{inh} - inhalation chronic reference dose in mg/kg-day
Confidence - L = low, M = medium, H = high, EST = estimated
SF_o - oral slope factor in $(mg/kg\text{-}day)^{-1}$
SF_{inh} - inhalation slope factor in $(mg/kg\text{-}day)^{-1}$
^ EPA weight-of-evidence classification system for carcinogenicity:

- A - human carcinogen
- B1 - probable human carcinogen. Limited human data are available
- B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
- C - possible human carcinogen
- D - not classifiable as to human carcinogenicity
- E - evidence of noncarcinogenicity for humans

-- information not available
* total chromium assumed to be chromium VI (most conservative)
** used dose and cancer risk values for dinitrotoluene - mixture

II.3.3.1 Exposure Assessment

Appendix 1 shows the equations and parameter values used in the calculation of intake values and the subsequent Hazard Index and excess cancer risk values for the individual exposure pathways. The appendix shows the parameters for both industrial and residential land-use scenarios. The equations are based on RAGS (USEPA, 1989). The parameter values are based on information from RAGS (USEPA, 1989) as well as other USEPA guidance documents and reflect the RME approach advocated by RAGS (USEPA, 1989).

Although the designated land-use scenario is industrial for this site, the risk values for a residential land-use scenario are also presented. These residential risk values are presented only to provide perspective on the potential for risk to human health under the more restrictive land-use scenario.

II.3.3.2 Risk Characterization

Table 3 shows that for the COCs, the Hazard Index value is 0.4 and the excess cancer risk is 2×10^{-5} for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust and volatile inhalation for the COCs. Table 4 shows that for the ER Site 109 associated background constituents, the Hazard Index is 0.01 and the excess cancer risk is 4×10^{-6} for the designated industrial land-use scenario.

For the residential land-use scenario, the Hazard Index value increases to 103 and the excess cancer risk is 3×10^{-4}. The number presented included exposure from soil ingestion, dust and volatile inhalation and plant uptake. Although USEPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, NM, to be eroded and, subsequently, for dust to be present even in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 4 shows that for the ER Site 109 associated background constituents, the Hazard Index increases to 1 and the excess cancer risk is 6×10^{-5}.

II.4 <u>Step 6 Comparison of Risk Values to Numerical Standards.</u>

The risk assessment analyses considered the evaluation of the potential for adverse health effects for both an industrial land-use scenario, which is the designated land-use scenario for this site, and also a residential land-use scenario.

Table 3. Risk Assessment Values for ER Site 109 COCs.

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Aluminum	8700 J	0.01	--	0.03	--
Arsenic	26 ND	0.08	2E-5	1.49	3E-4
Barium	630	0.01	--	0.09	--
Beryllium	0.56	0.00	1E-6	0.00	4E-6
Cadmium	99	0.19	4E-8	80.93	6E-8
Chromium, total*	350	0.07	9E-7	0.28	1E-6
Copper	560	0.01	--	2.51	--
Mercury	0.0158 J	0.00	--	0.03	--
Selenium	50 ND	0.01	--	17.59	--
Silver	8.3	0.00	--	0.34	--
2,4,6-Trinitrotoluene	0.075 ND	0.00	9E-10	0.00	4E-9
2,4-Dinitrotoluene	0.075 ND	0.00	--	0.03	--
2,6-Dinitrotoluene	0.075 ND	0.00	--	0.00	--
2-Amino-4,6-dinitrotoluene^	0.075 ND	0.00	2E-8	0.00	8E-8
4-Amino-2,6-dinitrotoluene^	0.075 ND	0.00	2E-8	0.00	8E-8
Nitrobenzene	0.075 ND	0.00	--	0.17	--
RDX	0.225 ND	0.00	1E-8	0.00	4E-8
HMX	0.225 ND	0.00	--	0.00	--
TETRYL	0.15 ND	0.00	--	0.00	--
m-Dinitrobenzene	0.075 ND	0.00	--	0.00	--
m-Nitrotoluene	0.075 ND	0.00	--	0.00	--
o-Nitrotoluene	0.075 ND	0.00	--	0.00	--
p-Nitrotoluene	0.075 ND	0.00	--	0.00	--
sym-Trinitrobenzene	0.075 ND	0.00	--	0.01	--
TOTAL		**0.4**	**2E-5**	**103**	**3E-4**

-- information not available
* total chromium assumed to be chromium VI (most conservative)
J - estimated value
ND - concentration is non-detect

Table 4. Risk Assessment Values for ER Site 109 Background Constituents.

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Aluminum	69,957^	NC	NC	NC	NC
Arsenic	4.4	0.01	3E-6	0.25	5E-5
Barium	130	0.00	--	0.02	--
Beryllium	0.65	0.00	1E-6	0.00	5E-6
Cadmium	0.9	0.00	4E-10	0.74	5E-10
Chromium, total*	1	0.00	3E-9	0.00	4E-9
Copper	15.4	0.00	--	0.00	--
Mercury	<0.1	--	--	--	--
Selenium	<1	--	--	--	--
Silver	<1	--	--	--	--
TOTAL		**0.01**	**4E-6**	**1**	**6E-5**

^ value from the NURE program (USGS, 1994) not used in background calculation
-- information not available
* total chromium assumed to be chromium VI (consistent with Table 3)

For the industrial land-use scenario, the Hazard Index calculated is 0.4; this is much less than the numerical standard suggested in RAGS (USEPA, 1989) of 1. The excess cancer risk is estimated at 2 x 10^{-5}. In RAGS, the USEPA suggests that a range of values (10^{-6} to 10^{-4}) be used as the numerical standard; the value calculated for this site is in the middle of the suggested acceptable risk range. Therefore, for an industrial land-use scenario, the Hazard Index risk assessment values are significantly less than the established numerical standards and the excess cancer risk is in the middle of the acceptable risk range. This risk assessment also determined risks considering background concentrations of the potential COCs for both the industrial and residential land-use scenarios. For the industrial land-use scenario, the Hazard Index is 0.01. The excess cancer risk is estimated at 4 x 10^{-6} . Incremental risk is determined by subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and therefore may appear to be inconsistent with numbers presented in tables and discussed in the text. The incremental Hazard Index is 0.37 and the incremental cancer risk is 1.7 x 10^{-5} for the industrial land-use scenario.

For the residential land-use scenario, the calculated Hazard Index is 103, which is above the numerical guidance. The excess cancer risk is estimated at 3 x 10^{-4}; this value is also above the suggested acceptable risk range. The hazard index for the associated background for the residential land-use scenario is 1. The excess cancer risk is estimated at 6 x 10^{-5}. For the residential land-use scenario, the incremental Hazard Index is 102.48 and the incremental cancer risk is 2.4 x 10^{-4}. The potential pathways considered for this calculation includes both soil ingestion, dust inhalation and plant uptake.

II.5 Step 7 Uncertainty Discussion

The data used to characterize Site 109, Building 9950 Firing Site, was provided by collecting 28 subsurface soil samples from fourteen soil boring locations and ten surface samples around and on top of Building 9950. The fourteen soil borings were randomly selected from a 150-foot by 200-foot grid area (ten foot centers). There are two surface sample locations at the site. At each location, five surface sample locations were randomly selected from a 15-foot by 15-foot grid area (five foot centers). This number of samples are deemed sufficient to establish whether COCs were detectable at the site. The COCs are HE, DU, RCRA metals, aluminum, copper, and beryllium. DU was removed from the COC list (see Section II.1). Samples sent to the on-site laboratory were analyzed by the inductively coupled plasma method for metals. Samples sent to the off-site laboratory were analyzed by Method 6010/7000 for metals and by Method 8330 for HE. All HE data was provided by the off-site laboratory and is considered definitive data and suitable for use in this risk assessment. The metal data achieved the data quality objective of 100 percent on-site laboratory analysis with 20 percent off-site laboratory analysis for confirmation. In addition, the DV II data verification review stated the metal data was acceptable for this risk assessment.

The conclusion from the risk assessment analysis is that the potential effects caused by potential COCs on human health are small compared to established numerical standards for the industrial land-use scenario. Calculated incremental risk between potential COCs and associated background indicate small contribution of risk from the COCs when considering the industrial land-use scenario.

The potential effects on human health are greater when considering the residential land-use scenario. Incremental risk between potential COCs and associated background also indicates a greater contribution of risk from the COCs. The increased effects on human health are primarily the result of including the plant uptake exposure pathway. Constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels), contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because ER Site 109 is designated as industrial land-use area (USDOE, 1996), the likelihood of significant plant uptake in this area is highly unlikely. The uncertainty in this conclusion is also considered to be small.

Because of the location, history of the site and the future land-use (USDOE, 1996), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis.

An RME approach was used to calculate the risk assessment values, which means that the parameter values used in the calculations were conservative and that the calculated intakes are likely overestimates. Maximum measured values of the concentrations of the COCs and minimum value of the 95th UTL or percentile background concentration value, as applicable, of background concentrations associated with the COCs were used to provide conservative results.

Table 2 shows the uncertainties (confidence) in the toxicological parameter values. There is a mixture of estimated values and values from the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1996b) and Integrated Risk Information System (IRIS) (USEPA, 1988, 1994) databases. Where values are not provided, information is not available from HEAST, IRIS, or USEPA regions. Because of the conservative nature of the RME approach, the uncertainties in the toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis.

The risk assessment values are acceptable for the industrial land-use scenario when compared to the established numerical standards. Though the residential land-use Hazard Index and excess cancer risk are above the numerical standards, it has been determined that future land-use at this locality will not be residential (USDOE, 1996). The overall uncertainty in all of the steps in the risk assessment process is therefore considered insignificant with respect to the conclusion reached.

II.6 Summary

The Building 9950 Firing Site, ER Site 109, had relatively minor contamination consisting of some inorganic compounds. Because of the location of the site on KAFB, the designated industrial land-use scenario (USDOE, 1996) and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion and dust and volatile inhalation for chemical constituents.

The residential land-use scenario includes the soil ingestion, inhalation, and plant uptake exposure pathways. Because the site is designated as industrial (USDOE, 1996) and the residential land-use scenario is presented to only provide perspective, the stated exposure pathways were included but provide a conservative risk assessment.

Using conservative assumptions and employing a RME approach to the risk assessment, the calculations for the COCs show that for the industrial land-use scenario the Hazard Index (0.4) is significantly less than the accepted numerical guidance from the USEPA. The estimated cancer risk (2×10^{-5}) is in the middle of the suggested acceptable risk range. The incremental Hazard Index is 0.37 and the incremental cancer risk is 1.7×10^{-5} for the industrial land-use scenario. Incremental risk calculation indicate that insignificant contribution to risk from the COCs considering an industrial land-use scenario.

The calculations for the COCs show that for the residential land-use scenario the Hazard Index (103) is above the accepted numerical guidance from the USEPA. The estimated cancer risk (3×10^{-4}) is also above the suggested acceptable risk range. The majority of the risk is associated with the inclusion of the plant uptake exposure pathway. Constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels), contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because ER Site 109 is an industrial site, the likelihood of significant plant uptake in this area is highly unlikely. For the residential land-use scenario, the incremental Hazard Index is 102.48 and the incremental cancer risk is 2.4×10^{-4}. Contribution of risk from the COCs was evident considering residential land-use, due to the plant uptake exposure pathway, but future use will be restricted to industrial land-use.

The uncertainties associated with the calculations are considered small relative to the conservativeness of the risk assessment analysis. It is therefore concluded that this site does not have significant potential to affect human health under an industrial land-use scenario.

III. Ecological Risk Assessment

III.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPECs) in soils from ER Site 109. The ecological risk assessment process performed for this site is a screening level assessment which follows the methodology presented in IT (1997) and SNL/NM (1997). The methodology was based on screening level guidance presented by USEPA (USEPA, 1992; 1996c; 1996d) and by Wentsel, et al. (1996) and is consistent with a phased approach. This assessment utilizes conservatism in the estimation of ecological risks, however, ecological relevance and professional judgment are also incorporated as recommended by USEPA (1996c) and Wentsel et al., (1996) to insure that the predicted exposures of selected ecological receptors reasonably reflect those expected to occur at the site.

III.2 Ecological Pathways

Site 109 is located in a grassland habitat. Major vegetation associated with the North Thunder Range includes a combination of woody shrubs (fourwing saltbush, yucca, winterfat), cacti (prickly pear), and assorted grasses (Sullivan and Knight, 1994). Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in surface and subsurface soil.

No threatened, endangered, or other special status species are known to occur at the site. Scattered individuals of the grama grass cactus (Pediocactus papyracanthus) occur in the grassland habitats of the North Thunder Range (Sullivan and Knight, 1994). This species had once been listed as endangered by the New Mexico Forestry and Resource Conservation Division (NMFRCD) and as a C2 candidate for federal listing by the U.S. Fish and Wildlife Service, but has since been removed from both special status categories by the respective agencies. A population of the Santa Fe milkvetch (Astragalus feensis), designated a rare and sensitive plant by the NMFRCD, was found to be abundant locally on hilltops near the northeast corner of the North Thunder Range (Sullivan and Knight, 1994), however, due to the lack of suitable habitat is not expected to occur at the site. As part of an ER site reconnaissance this site was visited on February 17, 1994. The site was found to be highly disturbed and did not contain habitat suitable for the occurrence of known sensitive species nor were any sensitive species observed at this facility (IT, 1995).

III.3 Constituents of Potential Ecological Concern

The COCs at this site are HE, metals (particularly lead and beryllium), and DU. Following the screening process used for the selection of potential COCs for the human health risk assessment, the inorganic COCs were screened against background upper tolerance limits (UTLs). Six inorganic analytes, arsenic, barium, cadmium, copper, selenium and silver, were identified as COPECs at Site 109. Two of these (arsenic and selenium) were not detected in either surface or subsurface samples (less than 5 ft. deep [IT, 1997]); however, the detection limits exceeded the UTLs of the background soil concentrations, and therefore, these analytes could not be excluded from the list of COPECs. High explosives were not detected, however, because explosive compounds do not have calculated background values, they are carried into the risk assessment analysis. Radiological field screening and gamma spectroscopy results were within the normal background range.

III.4 Receptors and Exposure Modeling

A non-specific perennial plant was used as the receptor to represent plant species at the site. Two wildlife receptors (deer mouse and burrowing owl) were used to represent wildlife use of the site. Exposure modeling for the wildlife receptors was limited to the food ingestion pathway. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion. Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled as an omnivore (50 percent of the diet as plants and 50 percent as soil invertebrates) and the burrowing owl as a strict predator on small mammals (100 percent of the diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 5 presents the species-specific factors used in modeling exposures in the wildlife receptors. Although home range is also included in this table, exposures for this screening-level assessment were modeled using an area use factor of 1, implying that all food items and soil ingested are from the site being investigated.

Table 5. Exposure Factors for Ecological Receptors at Environmental Restoration Site 109, Sandia National Laboratories, New Mexico

Receptor species	**Class/Order**	**Trophic level**	**Body weight (kg)[a]**	**Food intake rate (kg/d)[b]**	**Dietary Composition[c]**	**Home range (acres)**
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Omnivore	0.0239[d]	0.00372	Plants: 50% Invertebrates: 50% (+ Soil at 2% of intake)	0.27[e]
Burrowing owl (*Speotyto cunicularia*)	Aves/ Strigiformes	Carnivore	0.155[f]	0.0173	Rodents: 100% (+ Soil at 2% of intake)	34.6[g]

[a]Body weights are in kilograms wet weight.
[b]Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kilograms dry weight per day.
[c]Dietary compositions are generalized for modeling purposes. Default soil intake value of 2% of food intake.
[d]From Silva and Downing (1995).
[e]From USEPA (1993), based on the average home range measured in semi-arid shrubland in Idaho.
[f]From Dunning (1993).
[g]From Haug et al. (1993).

The maximum measured COPEC concentrations from both surface and subsurface soil samples (less than 5 ft. deep [IT, 1997]) were used to conservatively estimate potential exposures and risks to plants and wildlife at this site. In the case of arsenic, the detection limit from the on-site laboratory exceeded the measured concentrations of arsenic from the off-site laboratory. Therefore, the detection limit from the on-site laboratory was used as the maximum arsenic concentration in soil at this site. Detection limits from the on-site laboratory were also used for selenium and HE compounds, which were not otherwise detected but were retained due to the high detection limit.

Table 6 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 7 presents the maximum concentrations of COPECs in soil, the derived concentrations in the various food-chain elements, and the modeled dietary exposures for each of wildlife receptor species.

Table 6. Transfer Factors Used in Exposure Models for Constituents of Potential Ecological Concern at Environmental Restoration Site 109, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Arsenic	4.00×10^{-2} [a]	1.00×10^{0} [b]	2.00×10^{-3} [a]
Barium	1.50×10^{-1} [a]	1.00×10^{0} [b]	2.00×10^{-4} [c]
Cadmium	5.50×10^{-1} [a]	6.00×10^{-1} [d]	5.50×10^{-4} [a]
Copper	8.00×10^{-1} [e]	2.50×10^{-1} [d]	1.00×10^{-2} [a]
Selenium	5.00×10^{-1} [c]	1.00×10^{0} [b]	1.00×10^{-1} [c]
Silver	1.00×10^{0} [c]	2.50×10^{-1} [d]	5.00×10^{-3} [c]
HMX	2.74×10^{1} [f]	1.36×10^{1} [g]	3.42×10^{-8} [f]
RDX	1.22×10^{1} [f]	1.45×10^{1} [g]	1.46×10^{-7} [f]
Tetryl	4.31×10^{0} [f]	1.59×10^{1} [g]	9.32×10^{-7} [f]
2,4,6-trinitrotoluene	4.60×10^{0} [f]	1.58×10^{1} [g]	8.28×10^{-7} [f]
2-amino-4,6-dinitrotoluene	2.78×10^{0} [f]	1.65×10^{1} [g]	2.04×10^{-6} [f]
4-amino-2,6-dinitrotoluene	2.78×10^{0} [f]	1.65×10^{1} [g]	2.04×10^{-6} [f]
2,4-dinitrotoluene	2.78×10^{0} [f]	1.65×10^{1} [g]	2.04×10^{-6} [f]
2,6-dinitrotoluene	3.93×10^{0} [f]	1.60×10^{1} [g]	1.10×10^{-6} [f]
m-nitrotoluene	1.49×10^{0} [f]	1.74×10^{1} [g]	6.25×10^{-6} [f]
o-nitrotoluene	1.81×10^{0} [f]	1.71×10^{1} [g]	4.37×10^{-6} [f]
p-nitrotoluene	1.65×10^{0} [f]	1.73×10^{1} [g]	5.17×10^{-6} [f]
sym-trinitrobenzene	8.96×10^{0} [f]	1.49×10^{1} [g]	2.52×10^{-7} [f]
m-dinitrobenzene	5.33×10^{0} [f]	1.56×10^{1} [g]	6.37×10^{-7} [f]
Nitrobenzene	3.30×10^{0} [f]	1.63×10^{1} [g]	1.50×10^{-6} [f]

[a]From Baes et al. (1984).
[b]Default value.
[d]From Stafford et al. (1991).
[c]From NCRP (1989).
[e]From IAEA (1994).
[f]From equations developed in Travis and Arms (1988).
[g]From equations developed in Connell and Markwell (1990).

Table 7. Media Concentrations for Constituents of Potential Ecological Concern at Environmental Restoration Site 109, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Soil (maximum)[a]	Plant Foliage[a,b]	Soil Invertebrate[a,b]	Deer Mouse Tissues[a,c]
Arsenic	2.60×10^{1}	1.04×10^{0}	2.60×10^{1}	8.78×10^{-2}
Barium	6.30×10^{2}	9.45×10^{1}	6.30×10^{2}	2.34×10^{-1}
Cadmium	9.90×10^{1}	5.45×10^{1}	5.94×10^{1}	1.01×10^{-1}
Copper	5.60×10^{2}	4.48×10^{2}	1.40×10^{2}	9.54×10^{0}
Selenium	5.00×10^{1}	2.50×10^{1}	5.00×10^{1}	1.20×10^{1}
Silver	8.30×10^{0}	8.30×10^{0}	2.08×10^{0}	8.36×10^{-2}
HMX	2.25×10^{-1}	6.16×10^{0}	3.05×10^{0}	4.92×10^{-7}
RDX	2.25×10^{-1}	2.74×10^{0}	3.27×10^{0}	1.37×10^{-6}
Tetryl	1.50×10^{-1}	6.46×10^{-1}	2.39×10^{0}	4.42×10^{-6}
2,4,6-trinitrotoluene	7.50×10^{-2}	3.45×10^{-1}	1.19×10^{0}	1.98×10^{-6}
2-amino-4,6-dinitrotoluene	7.50×10^{-2}	2.08×10^{-1}	1.24×10^{0}	4.63×10^{-6}
4-amino-2,6-dinitrotoluene	7.50×10^{-2}	2.08×10^{-1}	1.24×10^{0}	4.63×10^{-6}
2,4-dinitrotoluene	7.50×10^{-2}	2.08×10^{-1}	1.24×10^{0}	4.63×10^{-6}
2,6-dinitrotoluene	7.50×10^{-2}	2.94×10^{-1}	1.20×10^{0}	2.58×10^{-6}
m-nitrotoluene	7.50×10^{-2}	1.11×10^{-1}	1.31×10^{0}	1.39×10^{-5}
o-nitrotoluene	7.50×10^{-2}	1.36×10^{-1}	1.29×10^{0}	9.74×10^{-6}
p-nitrotoluene	7.50×10^{-2}	1.24×10^{-1}	1.30×10^{0}	1.15×10^{-5}
sym-trinitrobenzene	7.50×10^{-2}	6.72×10^{-1}	1.12×10^{0}	7.06×10^{-7}
m-dinitrobenzene	7.50×10^{-2}	4.00×10^{-1}	1.17×10^{0}	1.57×10^{-6}
Nitrobenzene	7.50×10^{-2}	2.48×10^{-1}	1.22×10^{0}	3.45×10^{-6}

[a]Milligrams per kilogram. All are based on dry weight of the media.
[b]Product of the soil concentration and the corresponding transfer factor.
[c]Product of the average concentration in food times the food-to-muscle transfer factor times the wet weight-dry weight conversion factor of 3.125 (from USEPA, 1993).

III.5 Toxicity Benchmarks

Benchmark toxicity values for the plant and wildlife receptors are presented in Table 8. For plants, the benchmark soil concentrations are based on the Lowest-Observed-Adverse-Effect-Level (LOAEL) with the adverse effect being a 20 percent reduction of growth. For wildlife, the toxicity benchmarks are based on the No-Observed-Adverse-Effect-Level (NOAEL) for chronic oral exposure in a taxonomically similar test species. An avian toxicity value for silver was not found in the literature. In addition, insufficient toxicity data for the HE compounds precluded estimating potential risk to the terrestrial plant and burrowing owl.

III.6 Risk Characterization

The maximum soil concentrations and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. The results of these comparisons are presented in Table 9. Hazard quotients (HQs) are used to quantify the comparison with the benchmarks for wildlife exposure. Maximum soil concentrations for all the inorganic COPECs exceeded their respective plant benchmark values. In the deer mouse, HQs exceeded unity for arsenic (HQ = 16.4), barium (HQ = 5.85), cadmium (HQ = 4.86), copper (HQ = 1.60), and selenium (HQ = 15.3). In the burrowing owl, only the HQ for selenium (HQ = 3.30) exceeded unity.

III.7 Uncertainties

Many uncertainties are associated with the characterization of ecological risks at Site 109. These uncertainties result in the use of assumptions in estimating risk which may lead to an overestimation or underestimation of the true risk presented at a site. For this screening level risk assessment, assumptions are made that are more likely to overestimate risk rather than to underestimate it. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment include the use of the maximum measured soil concentration or maximum detection limit to evaluate risk, the use of wildlife toxicity benchmarks based on laboratory NOAEL values or estimated NOAELs based on toxicity information on surrogate compounds (e.g., many of the munitions), the use of maximum transfer factors found in the literature for modeling plant and mouse tissue concentrations, the use earthworm-based transfer factors or a default factor of 1.0 for modeling COPECs into soil invertebrates, and the use of 1.0 as the use factor for wildlife receptors regardless of seasonal use or home range size. In addition, risks to plants and birds from exposure to the HE compounds could not be estimated due to the lack of toxicity information.

Table 8. Toxicity Benchmarks for Ecological Receptors at Environmental Restoration Site 109, Sandia National Laboratories, New Mexico

		Mammalian NOAELs (mg/Kg/d)			Avian NOAELs (mg/Kg/d)		
Constituent of Potential Ecological Concern	Plant Benchmark[a] (mg/Kg)	Mammalian Test Species[b]	Test Species NOAEL[c]	Deer Mouse NOAEL[d]	Avian Test Species[e]	Test Species NOAEL[e]	Burrowing Owl NOAEL[f]
Arsenic	10	Lab mouse	0.126	0.133	Mallard	5.14	5.14
Barium	500	Lab rat	5.1	9.98	Chicks	20.8	20.8
Cadmium	3	Lab rat	1	1.89	Mallard	1.45	1.45
Copper	100	Mink	11.7	29.8	Chicks	47	47
Selenium	1	Lab rat	0.2	0.391	Screech owl	0.44	0.44
Silver	2	Lab rat[g]	17.8[g]	34.8	---[h]	---	---
HMX	---	Lab rat	10[g]	19.6	---	---	---
RDX	---	Lab rat	0.3[g]	0.587	---	---	---
Tetryl	---	Lab rat	13[i]	25.4	---	---	---
2,4,6-trinitrotoluene	---	Lab rat	1.6[j]	3.13	---	---	---
2-amino-4,6-dinitrotoluene	---	Lab rat	2.81[k]	5.50	---	---	---
4-amino-2,6-dinitrotoluene	---	Lab rat	1.93[k]	3.78	---	---	---
2,4-dinitrotoluene	---	Lab rat	0.54[k]	1.06	---	---	---
2,6-dinitrotoluene	---	Lab rat	0.36[k]	0.704	---	---	---
m-nitrotoluene	---	Lab rat	2.16[k]	4.23	---	---	---
o-nitrotoluene	---	Lab rat	1.79[k]	3.50	---	---	---
p-nitrotoluene	---	Lab rat	3.94[k]	7.71	---	---	---
sym-trinitrobenzene	---	Lab rat	0.37[l]	0.724	---	---	---
m-dinitrobenzene	---	Lab rat	0.08	0.156	---	---	---
Nitrobenzene	---	Lab mouse	1.17[l]	1.24	---	---	---

[a]From Will and Suter (1995).
[b]From Sample et al. (1996), except where noted. Body weights (in kilograms) for NOAEL conversion are: lab mouse, 0.030; lab rat, 0.350 (except where noted and for cadmium, 0.303); and mink, 1.0.
[c]From Sample et al. (1996), except where noted.
[d]Based on NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.239 kilograms and a mammalian scaling factor of 0.25.
[e]From Sample et al. (1996).
[f]Based on NOAEL conversion methodology presented in Sample et al. (1996). The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.
[g]From USEPA (1997).
[h]--- designates insufficient toxicity data.
[i]From Talmage et al. (1996).
[j]From Ryon (1987).
[k]Estimated using LD_{50} information specific to the compound (e.g., RTECS, 1997) and LD_{50} and NOAEL information for TNT as described in Sample et al. (1996).
[l]Estimated using LD_{50} information specific to the compound (e.g., RTECS, 1997) and LD_{50} and NOAEL information for m-dinitrobenzene as described in Sample et al. (1996).

Table 9. Comparisons to Toxicity Benchmarks for Ecological Receptors at Environmental Restoration Site 109, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Exceeds Plant Hazard Quotient	Deer Mouse Hazard Quotient	Burrowing Owl Hazard Quotient
Arsenic	**2.60×10^{0}**	**1.64×10^{1}**	1.32×10^{-2}
Barium	**1.26×10^{0}**	**5.85×10^{0}**	6.88×10^{-2}
Cadmium	**3.30×10^{1}**	**4.86×10^{0}**	1.60×10^{-1}
Copper	**5.60×10^{0}**	**1.60×10^{0}**	4.92×10^{-2}
Selenium	**5.00×10^{1}**	**1.53×10^{1}**	**3.30×10^{0}**
Silver	**4.15×10^{0}**	2.39×10^{-2}	---[a]
HMX	---	3.67×10^{-2}	---
RDX	---	7.98×10^{-1}	---
Tetryl	---	9.30×10^{-3}	---
2,4,6-trinitrotoluene	---	3.81×10^{-2}	---
2-amino-4,6-dinitrotoluene	---	2.05×10^{-2}	---
4-amino-2,6-dinitrotoluene	---	2.99×10^{-2}	---
2,4-dinitrotoluene	---	1.07×10^{-1}	---
2,6-dinitrotoluene	---	1.66×10^{-1}	---
m-nitrotoluene	---	2.62×10^{-2}	---
o-nitrotoluene	---	3.17×10^{-2}	---
p-nitrotoluene	---	1.44×10^{-2}	---
sym-trinitrobenzene	---	1.93×10^{-1}	---
m-dinitrobenzene	---	7.83×10^{-1}	---
Nitrobenzene	---	9.25×10^{-2}	---

Bold text indicates hazard quotient greater than one.
[a]--- designates insufficient toxicity data available for risk estimation purposes.

III.8 Summary

Potential risks were indicated for all three ecological receptors at Site 109; however, the use of the maximum measured soil concentration or maximum detection limit to evaluate risk provided the "worst case" scenario for the risk assessment and may not reflect actual site conditions. Detection limits were used to evaluate risk for arsenic, selenium, and HE compounds. The detection limits for arsenic and selenium exceeded their respective plant benchmark values and also produced HQs greater than 1.0 in the deer mouse. Maximum measured soil concentrations for barium, cadmium, and copper exceeded their respective plant benchmark values, and also produced HQs greater than 1.0 for the deer mouse. The maximum measured soil concentration for silver exceeded its plant benchmark value, but did not result in a HQs greater than 1.0 in the deer mouse. The maximum measured soil concentration for selenium resulted in a potential risk to all ecological receptors, and was the only COPEC concentration that resulted in an HQ greater than 1.0 for the burrowing owl. Due to insufficient toxicity data for HE compounds potential risk estimates could not be determined for the terrestrial plant or the burrowing owl. Because none of the HE compounds (using the detection limits) resulted in hazard quotients greater than unity for the deer mouse and the home range for the owl is 128 times greater than that of the mouse, it is unlikely that the owl would be adversely affected by any HE compounds at this site.

The detection limits used in the screening assessment were the highest reported in the sampling and analysis effort. Detection limits used for arsenic and selenium were from the on-site laboratory data. A comparison against detection limits from the off-site laboratory indicate values for arsenic and selenium to be within the range of soil background values. It is therefore unlikely that arsenic and selenium from Site 109 are of ecological concern.

Maximum detected concentrations of barium, cadmium, copper, and silver resulted in predictions of ecological risk. Barium in soil from Site 109 had a maximum concentration of 630 mg/kg (HQ=1.26, 5.85, and 0.16 for the plant, deer mouse, and burrowing owl, respectively). The average of 13 data points for barium from the site was approximately 220 mg/kg. This concentration would result in a HQ less than one for the plant. Out of the 220 mg/kg, about 130 mg/kg is contributed by the background soil. The incremental risk in term of the HQ for the deer mouse is less than one. In addition, the LOAEL value for barium is about 4 times of that of NOAEL. Overall, the ecological risk contributed by the presence of barium in Site 109 is not predicted to be significant. The cadmium analyses included a maximum value of 99 mg/kg (HQ=33 and 4.86 for the plant and deer mouse, respectively), and concentrations of 2.6, 1.14, 0.332 (J) mg/Kg, and nine nondetects. It is very possible the 99 mg/kg was an anomaly and the use of this value may have resulted in an overestimation of risk. Use of more realistic exposure concentrations such as the 95% UTL or average concentration would result in a considerable reduction of the predicted risk. The copper analytical results for Site 109 consisted of a maximum value of 560 mg/kg (HQ=5.6 and 1.6 for the plant and deer mouse, respectively). The next highest concentration was 210 mg/kg. In addition, the sample set had five data points less than 60 mg/kg and six nondetects. Based on this data set, the average copper concentration in soil is estimated to be less than 100 mg/Kg which would produce a HQ less than one for the ecological receptors. Finally, the analytical results for silver in soil consisted of 8.3, 2.7, 1.1 mg/kg, and seven nondetects. The 8.3 mg/kg of silver in soil produced a HQ of 4.15 for plants. The average value of this data set would produce a HQ of less than unity for Site 109.

Based on a more detailed examination of analytical detection limits, background concentrations, and the entire data set for chemical analyses, it is reasonable to conclude that the COPECs at Site 109 are not of significant ecological concern.

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APPENDIX 1.

Sandia National Laboratories Environmental Restoration Program

EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

BACKGROUND

Sandia National Laboratories (SNL) proposes that a default set of exposure routes and associated default parameter values be developed for each future land-use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM ER sites have similar types of contamination and physical settings, SNL believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the USEPA Region VI and NMED, SNL proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all Environmental Restoration sites exist within the boundaries of the Kirtland AFB. Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/ER draft Environmental Assessment (DOE, 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land use scenarios for the SNL/NM ER sites. At this time, all SNL/NM ER sites have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based on a residential land use scenario. All three land use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent hazard index, risk and dose values. EPA (EPA, 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water;
- Ingestion of contaminated soil;
- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;

- Ingestion of contaminated meat, eggs, and dairy products;
- Ingestion of contaminated surface water while swimming;
- Dermal contact with chemicals in water;
- Dermal contact with chemicals in soil;
- Inhalation of airborne compounds (vapor phase or particulate), and;
- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based on the location of the SNL ER sites and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM ER sites, there does not presently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on-site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL, 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land use scenarios, SNL/NM ER has therefore excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM ER site:

- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products; and
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For the residential land-use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based on this evaluation, for future risk assessments, the exposure routes that will be considered are shown in Table 1. Dermal contact is included as a potential exposure pathway in all land use scenarios. However, the potential for dermal exposure to inorganics is not considered significant and will not be included. In general, the dermal exposure pathway is generally considered to not be significant relative to water ingestion and soil ingestion pathways but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Table 1. Exposure Pathways Considered for Various Land Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil
Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

EQUATIONS AND DEFAULT PARAMETER VALUES FOR IDENTIFIED EXPOSURE ROUTES

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA, 1989a and 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL, 1993). Also shown are the default values SNL/NM ER suggests for use in Reasonable Maximum Exposure (RME) risk assessment calculations for industrial, recreational, and residential scenarios, based on EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL, 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., Hazard Quotient/Index, excess cancer risk, or radiation total effective dose equivalent [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \quad (1)$$

where

C	= contaminant concentration (site specific);
CR	= contact rate for the exposure pathway;
EFD	= exposure frequency and duration;
BW	= body weight of average exposure individual;
AT	= time over which exposure is averaged.

The total risk/dose (either cancer risk or hazard index) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 10^{-4} to 10^{-6}. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the Hazard Index) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard Hazard Index of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA, 1989) and the RESRAD Manual (ANL, 1993). Table 2 shows the default parameter values suggested for used by SNL at ER sites, based on the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are

Table 2. Default Parameter Values for Various Land Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure frequency (d/y)	***	***	***
Exposure duration (y)	30[a,b]	30[a,b]	30[a,b]
Body weight (kg)	70[a,b]	56[a,b]	70 adult[a,b] 15 child
Averaging Time (days) for carcinogenic compounds (=70 y x 365 d/y) for noncarcinogenic compounds (=ED x 365 d/y)	25550[a] 10950	25550[a] 10950	25550[a] 10950
Soil Ingestion Pathway			
Ingestion rate	100 mg/d[c]	6.24 g/y[d]	114 mg-y/kg-d[a]
Inhalation Pathway			
Inhalation rate (m^3/yr)	5000[a,b]	146[d]	5475[a,b,d]
Volatilization factor (m^3/kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m^3/kg)	1.32E9[a]	1.32E9[a]	1.32E9[a]
Water Ingestion Pathway			
Ingestion rate (L/d)	2[a,b]	2[a,b]	2[a,b]
Food Ingestion Pathway			
Ingestion rate (kg/yr)	NA	NA	138[b,d]
Fraction ingested	NA	NA	0.25[b,d]
Dermal Pathway			
Surface area in water (m^2)	2[b,e]	2[b,e]	2[b,e]
Surface area in soil (m^2)	0.53[b,e]	0.53[b,e]	0.53[b,e]
Permeability coefficient	chemical specific	chemical specific	chemical specific

*** The exposure frequencies for the land use scenarios are often integrated into the overall contact rate for specific exposure pathways. When not included, the exposure frequency for the industrial land use scenario is 8 h/d for 250 d/y; for the recreational land use, a value of 2 hr/wk for 52 wk/y is used (EPA, 1989b); for a residential land use, all contact rates are given per day for 350 d/y.

[a] RAGS, Vol 1, Part B (EPA, 1991).

[b] Exposure Factors Handbook (EPA, 1989b)

[c] EPA Region VI guidance.

[d] For radionuclides, RESRAD (ANL, 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

[e] Dermal Exposure Assessment, 1992.

suggested for use for the various exposure pathways based on the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

Summary

SNL proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land-use scenario. There are no current residential land-use designations at SNL ER sites, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land-use, SNL will provide risk parameter values based on a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on Sandia ER sites. The parameter values are based on EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

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ADDITIONAL /SUPPORTING DATA

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